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Fuel Utilization and Smoke Abatement in Salt Lake City

By OSBORN MONNETT

In the smoke-abatement work done in Salt Lake City a careful analysis of fuel-utilization equipment and methods was made. This article gives this portion of the Bureau of Mines report, done in co-operation with the City of Salt Lake and the University of Utah. Some of the power- and heating-plant conditions found in this investigation are described. Subsequent articles will take up fuels available to Salt Lake City, and the formation of a smoke cloud. Published with permission of the Director, Bureau of Mines.

IN CONNECTION with a smoke-abatement investigation a fuel survey of Salt Lake City was made to determine the amount of coal burned in the city, the amount burned by different classes of fuel users, the source of the coal and its characteristics. The amount of coal used by the different classes of fuel consumers except for residence and domestic use was obtained by means of questionnaires sent to all coal consumers. The information obtained was tabulated under the following heads: Apartment houses, business houses, churches, cleaning and dyeing establishments, dairies, creameries, hotels, hospitals, industrial boiler plants, laundries, office buildings, central heating plants, public buildings, schools, residences and locomotives. The coal consumed by residences was determined by a house-to-house canvass made by the Boy Scouts. This canvass also included a tabulation of domestic heating and cooking equipment. The quantities used are shown in Table I.

TABLE I. DISTRIBUTION OF COAL AND MEAN SMOKE DENSITY FOR VARIOUS CLASSES OF PLANTS

Name	Total for Summer and Winter	Tons Coal Winter 1918-19	Tons Coal Summer 1918-19	Mean Density
Apartment houses	14,470.25	10,988.4	3,481.9	15.71
Business houses	8,183.10	6,760.0	1,423.1	16.55
Churches	1,089.95	958.6	131.4	22.02
Cleaning and dyeing establishments	830.70	427.9	402.8	18.51
Dairies and creameries	849.00	454.8	394.2	23.17
Hotels	7,790.20	7,790.2	1,655.5	14.51
Hospitals	6,176.90	3,550.6	2,626.3	22.02
Industrial furnaces	45,514.40	18,042.3	27,472.1	13.65
Industrial boiler plants	78,040.60	40,621.8	37,418.8	19.16
Laundries	12,413.70	5,787.8	6,625.9	15.52
Office buildings and central heating plants	32,666.70	26,034.8	6,631.9	28.36
Public buildings, clubs, etc.	3,660.50	3,029.2	631.3	16.90
Schools	6,786.90	5,973.2	813.7	20.38
Railroad locomotives	53,140.00	24,517.0	28,623.0	26.36
Residences	210,000.00	168,105.0	41,895.0	7.98
Miscellaneous	31,589.10	25,287.1	6,302.0	15.00
Total	513,202.00			

The Ringlemann chart method of observation, as used throughout the survey, consisted of making readings of the density of smoke issuing from the stack under observation every fifteen seconds, the results being set down on the form as shown in Fig. 3. The readings, which were taken over one-hour periods, were all calculated to a standard based on No. 1 smoke performance of one plant with another. These readings were taken for the different classes of smoke producers over all hours of the day, the result being that a mathematical record was made available regarding the performance of the various plants from a smoke standpoint. This, when taken with the coal consumed by the different classes of smokers, makes it possible to figure the percentage of the city smoke made by each class for the year or for any period of the year over which it is desired to have this information. Industrial and large heating plants in the average city constitute the heaviest smokers, making a total of 39 per cent of the smoke in the heating season. A survey of the equipment in these plants was made in order to develop the type of plant which was making the smoke and methods of reconstruction necessary to reduce it. While it was not primarily the object of the investigation to do any considerable amount of actual smoke-abatement work, it was thought advisable to do enough engineering work in a list of typical plants to indicate the line along which the problem must be attacked in the future. A list of twenty-five of the worst smokers was selected, and engineers were sent to make surveys and recommendations in these plants. As an indication of the conditions found, a list of the plants with their equipments is presented herewith, with the percentage of the smoke density found during the investigation.

TABLE II. EQUIPMENT AND SMOKE DENSITY OF TWENTY-FIVE OF THE WORST SMOKERS

		Per Cent Smoke Density
1.	One ideal sectional No. S-28-7	66.8
2.	4—375 Gary boilers	
	4—Westinghouse underfeed	48.6
3.	1—H. R. T. boiler, hand-fired	45.3
4.	1—No. S-25-7 Ideal steam heater	42.5
5.	1—80 hp. Erie tubular boiler	42.3
6.	1—Economic H. R. T. boiler, hand fired	39.6
7.	2—40 hp. H. R. T. boilers	
	1—60 hp. H. R. T. boiler	38.7
8.	3—100 hp. B. & W. boilers	
	2—American stokers	34.5
9.	2—Kewanee H. R. T. boilers, 100 hp	
	2—Hawley downdraft, 100 hp	
	1—Kewanee, 50 hp	
	1—American stoker	31.0
10.	1—150 hp. marine boiler, brick furnace	
	1—40 hp. locomotive type boiler	30.6
11.	6 ft. 6 in., x 16 ft. H. R. T.	
	D-12 Herbert downdraft	30.1
12.	4—100 hp. B. & W. boilers	
	4—American stokers	29.0
13.	3—200 hp. boilers	
	3—American stokers	27.7
14.	1—No. 29 Cornell sectional	26.7
15.	2—80 hp. Kewanee boilers, hand fired	25.9
16.	2—60 hp. H. R. T. boilers	25.5
17.	1—50 hp. H. R. T. boiler	25.0
18.	Kewanee boiler, hand fired	24.8
19.	2—80 hp. H. R. T. boilers	23.6
20.	1—U. S. radiator sectional, hand fired	22.7
21.	2—45 hp. Kewanee boilers, hand fired	22.0
22.	4—150 hp. Kewanee boilers	
	4—American stokers	21.8
23.	1—150 hp. H. R. T. boiler	
	Hawley down-draft furnace	21.3
24.		21.2
25.	2—125 hp. Kewanee boilers	
	2—2—American stokers	20.9

In going over this list, it will be noticed that a considerable proportion of these plants are already equipped for smokeless operation. At the same time some of those so equipped are making the highest smoke densities. This indicates that one of the important factors in future smokelessness is that of supervision.

This is also shown clearly in Table III in which smoke densities of many installations properly equipped are higher, through careless handling, than in other plants not supplied with proper equipment.

As the work progressed, many more plants were visited, conditions found and recommendations made

FIG. 1. SALT LAKE CITY COVERED BY SMOKE CLOUD

being listed in detail herewith. From the information given one cannot but be impressed with the necessity for closer supervision of boiler installations not only from the standpoint of smoke abatement, but also of safety. Most states have stringent regulations regarding the use of second-hand boilers, designed to prevent boiler explosion. The unusually large number of boilers that have been installed second-hand in Salt Lake City indicates that this territory has been a market for boilers that would have been difficult to dispose of in other places. A partial list of plants visited as given herewith, together with the conditions found, will be valuable in pointing the way to methods of procedure for those in charge of the work in the future. Among the plants visited was one consisting of six 150-hp. horizontal return tubular boilers fired with six Molock stokers. It was found there was no need of any smoke from this plant if operated properly. Stokers were feeding too fast, which caused steam to rise and the fan to slow down, thus reducing the air blast and giving insufficient air to completely burn the fuel. Stokers should be set at a slower speed with respect to the blower.

Another plant consisting of one 80- and one 75-hp. horizontal return-tubular boiler was visited. One boiler here was found to have insufficient combustion space and emitted very much smoke. The other one in the brick setting was full of air leaks, causing insufficient operation. This boiler is also set far too low and should be raised to the required height for a boiler of this type and equipped with a reverse No. 8 furnace. At present only one boiler is in use at a time. If the contemplated future load is sufficient for the two boilers, probably the best way out of the difficulty would be to cover the brick setting with a good grade of boiler covering to stop air leaks and then install the underfeed stoker under both boilers. If only one boiler is needed, it would probably be cheaper and more satisfactory to raise the boiler, which is now set in brick, to the required height and install a wing-wall furnace. A plant consisting of three 110-hp. B. & W. boilers, set with front header six feet from the floor was visited and it was found that boilers are fired with three American stokers. The plant smoked only at periods when fires were being cleaned. The boilers are set too low for really proper smokeless operation, but with the usual load they can operate without objectionable smoke. Another plant consisting of one 80-hp. horizontal return-tubular boiler in regular use and one 50 hp. boiler which is used when the other one is being cleaned or overhauled, was found to be one of the simplest to clean up. Smoke can be prevented by the cracking of the doors for a few minutes after each firing. An automatic air-admission device on the firedoor would assist the fireman in abating smoke, as it would be easier to admit sufficient oxygen over the fire with this device than by cracking of the doors. The damper in the stack is warped so badly that it cannot be closed; this should be remedied. There is no need for this plant to make any objectionable smoke.

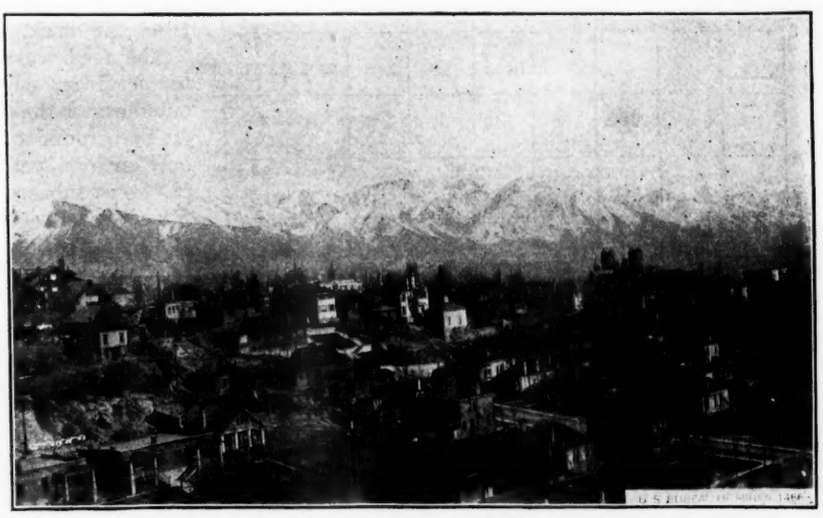

FIG. 2. SALT LAKE CITY WITH SMOKE CLOUD REMOVED

A plant consisting of three 100-hp. B. & W. boilers, fired with three American stokers was investigated and it was found that the boilers are set five feet under the front leader, which is far too low for smokeless operation with Utah coals. The combustion chamber is also too narrow, giving in all a very unsatisfactory condition for smoke abatement. Practically all methods of opera-

tion were tried from a thin fuel bed to the very thickest that could be carried and from a very light pressure in the retorts to a very heavy blast. If the fire is not disturbed, not much smoke is produced, but stokers throw the fuel to one side of the combustion chamber and soon it is impossible to burn the fuel sufficiently even to hold steam unless fires are spread evenly over the grate surface. The disturbing of the fire produces volumes of dense black smoke. With the present setting it is impossible to operate the plant in any way with satisfactory results as to smoke density. A Dutch-oven

TABLE III. RELATIVE SMOKE DENSITIES OF VARIOUS BOILER AND FURNACE EQUIPMENT

This is the way in which they were operated in Salt Lake City during the winter of 1919-20.

	H. R. T. Boilers Per Cent Smoke Density	Stokers Per Cent Smoke Density	Down Draft Per Cent Smoke Density	Up Draft Per Cent Smoke Density
Apartment houses	.....	.....	15.42	16.33
Business houses	.....	.....	12.95	15.36
Heating plants	20.70	19.93	7.64	19.93
Hospitals	30.6	29.0	.....	.....
Hotels	15.75	.....	7.53	13.30
Power plants	27.74	17.6	15.20	.....

setting was worked out with the resetting of these stokers, dropping the stokers one foot to move them out in front 3½ feet. The management is going to equip one boiler with a setting and see what results are obtained. If the results are satisfactory, the remaining two boilers will be so equipped. If this is not satisfactor, some other method will be devised to overcome the difficulty.

A modern plant, having been built only a few years, was found to be one of the city's most offensive smokers. It consists of two 260-hp. B. & W. boilers and one

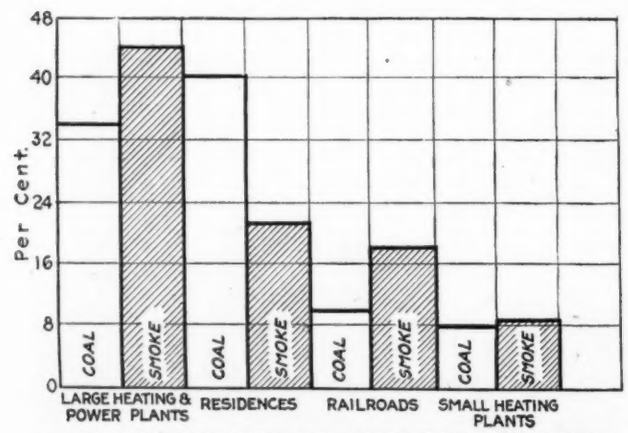

FIG. 3. SHOWING PERCENTAGE OF COAL AND SMOKE PRODUCED

130-hp. B. & W. boiler. The boilers are fired with five Jones stokers. The boiler settings are very badly cracked and are full of air leaks, also one 4-in. pipe in which combustion chamber is letting in cold air. The pipes were put in to drain the water out when washing the boilers and were not plugged up during the operation of the plant, and hence they admit large volumes of cold air at a point where it should not assist in the combustion but only help to cool the boiler down. There are also bad leaks around back buckstays on the two big boilers. The front doors on the big boilers do not shut tight. This condition should be remedied at once. Asbestos is out between the headers and should be replaced. While the boilers are set too low to carry more than their rated load with Utah fuels, if these air leaks are remedied and stokers are operated carefully, this plant should give no objectionable smoke up to the rating of the boilers.

In a boiler plant consisting of two 100-hp. locomotive-type boilers, fired with Type E American stokers, which came under the notice of the investigators, it was found that the fireman does not keep enough fuel in his fur-

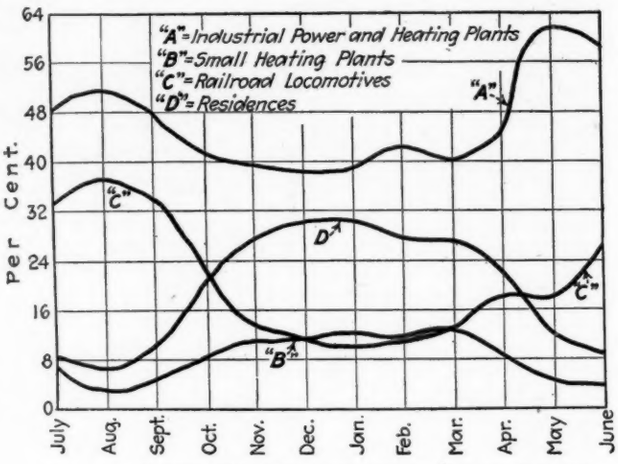

FIG. 4. CURVES SHOWING PERCENTAGE OF SMOKE DURING YEAR, FOR VARIOUS PLANTS

nace so that when the load comes upon him he has something to fall back upon. This necessitates the crowding of a lot of fresh fuel into the furnace whenever a heavy load comes upon the plant. The fireman has also made a practice of assisting the stoker at this point by throwing a lot of coal into the furnace directly; this results in enormous clouds of black smoke being emitted from the stack.

The feed water is fed into the boiler at city-water temperature, while the feed-water heaters stand idle outside and the water from the heating coils runs out on the ground or into the sewer. The flues are blown only once in two weeks, leaving an average of from one to twelve tubes entirely blocked with soot.

There seems to be no one willing to assume the responsibility of putting things into shape. It is likely that the only way that this plant can be reached is through the higher officials of this division of the railroad. Nothing can be done with the men in immediate charge.

Large power and heating plants have in the past been installed in Salt Lake City without necessary supervision on the part of the city. Some of these plants are in a rundown, not to say dangerous, condition and should be rebuilt or abandoned.

Standard methods of boiler and furnace setting will result in the smokeless performance of boiler plants using Utah coals.

Supervision of operation on the part of the city is imperative, as many plants which could operate without dense smoke are bad smokers through lack in this regard.

LOCOMOTIVES

Locomotive smoke to some has seemed the most difficult of control, but many cities in the Middle West have wrestled with this phase of the subject and the results have been more encouraging than was at first supposed to be possible.

In the last ten years standardized equipment has been developed as an aid to smoke abatement on locomotives. This equipment consists, briefly, of multiple-tip blowers, quick-opening blower valves and induction tubes located in the sides of the firebox, calculated to supply the necessary air for complete combustion. This equipment is simple, readily applied by ordinary boilermakers and has been discussed in detail in the proceedings of the Master Car Builders Association and in the annual conventions of the Traveling Engineers Association.

The railroad yards in Salt Lake City, however, serve to show that there are no physical difficulties in railroad operation in Salt Lake City comparable with the difficulties encountered in some other cities. The average smoke density of locomotives in cities without supervision of smoke performance is 49 per cent. The average smoke density of locomotives in Salt Lake City is 26 per cent. Locomotives can be and are operated in all classes of service with smoke densities below 7½ per cent, which generally brings this class of smoke down to a negligible quantity.

The railroad situation in Salt Lake City, when compared to the problem met with elsewhere, is an easy one and should be capable of vast improvement over present conditions.

Residences

While the residences burn nearly one-half the total coal consumed in the city, the fact that it is distributed so widely results in dissipating the smoke formed to a large extent so that the main effect of the residence smoke is the produtcion of a haze which hangs over the city in the winter and which is more noticeable on Sundays when the industrial smoke is at a minimum.

A house-to-house canvass indicates that there are 2,413 round sectional cast-iron hot-water and steam boilers; 707 square sectional cast-iron steam and hot water boilers; 4,600 hot-air furnaces; 15,150 heating stoves; 18,120 coal ranges; 8,000 gas ranges and 1,500 electric ranges in use in the city. This serves to indicate the relative importance of the different classes of smoke producers used in the residences. In attacking this part of the problem a series of experiments were conducted at the laboratory of the University of Utah with different domestic equipment, the results later being substantiated by tests run on equipment actually installed in residences.

With a reasonable amount of care and attention Utah bituminous coal can be burned in domestic equipment in nearly a smokeless manner. In starting a fire the smokeless method is much the best to use and in adding fresh coal to the fire the alternate method of firing is the most desirable.

Conclusions

Residence smoke can be greatly reduced by the education of householders in proper methods of firing, using the equipment already installed.

Smokeless apparatus is available for residences purposes in the case of new buildings or the replacement of old equipment.

From all available information it appears that the possibility of depending on anthracite as a source of smokeless fuel for Salt Lake City is very remote.

The use of coke for domestic fuel offers a solution of the residence problem. Utah has at least two coals suitable for the production of coke for domestic purposes. High-temperature processes produce a coke difficult to ignite and bring up a difficult problem in the disposal of gas. Low-temperature coke is a more suitable domestic fuel and the byproducts produced are easier of disposal.

Low-temperature coking is not yet on an established commercial basis in the United States, but gives every promise of being on such a basis in the course of the next few years. In view of the limited gas market in Salt Lake City and of the superiority of low-temperature coke as a domestic fuel, the low-temperature process seems well worth careful consideration as a future solution of the domestic smoke problem.

Natural-Gas Production Figures

The United States Geological Survey has just reported the 1918 production and consumption figures for natural gas. These figures show that a little over 720 billion cubic feet was produced and marketed that year. The value of this production at 21½c. per thousand feet is a little over $153,000,000. As usual, West Virginia, Oklahoma, Pennslyvania and Ohio led in the production, ranking in the order named. Pennsylvania, Ohio, West Virginia and Oklahoma is the order of consumption, showing, as usual, the large export of gas from West Virginia to Pennsylvania and Ohio and the considerable export from Oklahoma to Kansas and adjacent territory.

There is a very wide range in the average price at which natural gas is sold by the producer in various parts of the country. The figure for Wyoming is 3.59c. per thousand feet; in New York 67.05c., and in Michigan 89.08c. per thousand feet.

There is a decided tendency toward an increase in the percentage of gas sold for domestic use and a corresponding decrease in the percentage used industrially. This is in line with the recommendations of the Conservation Commission, which has recently been studying the subject, and the natural result of the gradual increase in the price at which gas is sold tending to make its use industrially less advantageous than formerly. This report shows that the 7,100 producers supplied 2,500,000 domestic consumers and 16,500 industrial consumers. The average price paid by the former group is 31.35c. and by the latter 15.23c. per thousand feet. The total volume of gas used industrially is, however, still considerably greater than that used in domestic equipment, amounting to about 60 per cent of the total. Of this, manufacturing takes slightly more than the production of industrial power.

Although about 30 per cent of the wells drilled in 1918 were dry, the total number of wells productive at the end of the year had increased by about 1,000 over the number productive at the beginning of the year. The total productive Dec. 31, 1918 was 40,369. The land controlled by natural-gas producers at the end of the year was nearly one million acres less than at the beginning of the year, indicating a strong tendency toward a smaller acreage of wells. This in itself is a decided indication of the decadence of natural-gas production. The area controlled at the end of the year per productive well was 360 acres.

In blowing engines the pressures and temperatures are low and the lubrication of the cylinders may not require a special type of oil, but it is the best policy to use an oil suitable for the high-pressure type of piston compressor.

Steam-Engine Operation and Maintenance—Why Valve Gears Get Out of Order

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A POUND in an engine may be caused by faulty or deranged valve setting. Fig. 1 shows an indicator diagram in which the admission line rises above the steam line, forming a loop at the end. This indicates that the compression rises to a higher pressure than the initial steam pressure. On a Corliss engine the higher compression will make the valve lift off its seat and drop back as soon as steam is admitted to the cylinder. The cause of it may be too much exhaust lap, or the eccentric may be set wrong. The latter is likely to be the case if the engine has a separate eccentric for the exhaust, which permits the regulation of the compression independently of the action of the steam valves. Another pound may be caused by too much steam load. This will be indicated on a diagram by the admission line having a very decided outward curve or slant, shown in Fig. 1. If there is play in the boxes, they will be forced against the pins with a violent blow instead of a gradual and easy motion due to compression alone.

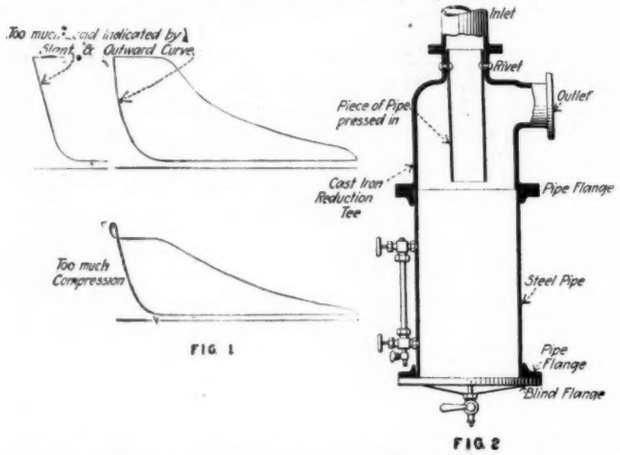


FIG. 1. TYPICAL INDICATOR DIAGRAMS SHOWING FAULTY VALVE GEAR. FIG. 2. STEAM SEPARATOR AN ENGINEER MAY MAKE ON THE JOB

Since on a number of engines the eccentric is held on the shaft by setscrews, it is no uncommon occurrence to have one slip, which causes a derangement of the valve motion, sometimes to such an extent that the engine will stop. The diagrammatic view of a single-eccentric Corliss valve gear in Fig. 3 shows what the effect will be if the eccentric slips back 30 deg. The crank is shown on the dead center at the beginning of the forward stroke, engine running over. For this position the correct place of the eccentric would be at *A*, but it has slipped back to *B*. The result of this is that the head-end steam valve, which should be in the lead position, is closed and the head-end exhaust valve is open. As the crank advances, the steam valve will open as soon as the eccentric is in the vertical position, and the exhaust valve will be on the lap. This is the mid-position for the whole valve motion. Continuing the motion of the crank for one revolution will result in a diagram something like the one shown in the detail.

Engines with releasing valve gears may become noisy under greatly varying loads. If a heavy load is instantly thrown off, as it is with elevators and pumps or in rolling mills, there is bound to be more or less noise in the valve gear. The dashpots will stick on a light load and are forced down by the hook or steam lever; a sudden increase in load will make them slam. This is about the most unsatisfactory service that can be imagined for a pair of dashpots, for which they must have plenty of reserve power. The old-time pots with two chambers, one to create the necessary vacuum and the other for cushioning, can be made to function well by careful fitting, but for very trying conditions a spring dashpot, like that which is shown in Fig. 4, is more reliable.

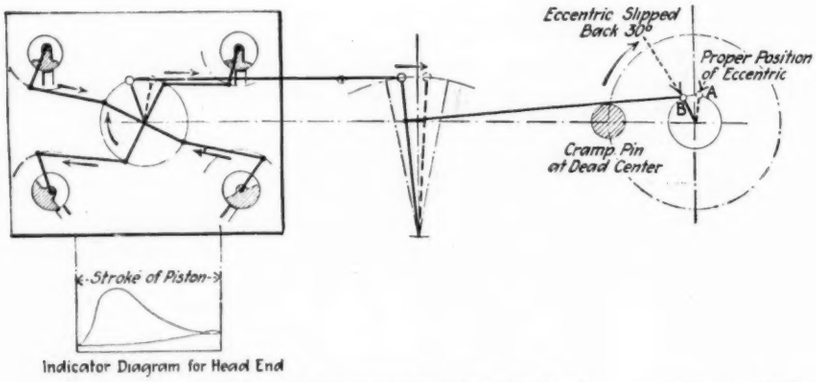


FIG. 3. DERANGED CORLISS VALVE GEAR DUE TO SLIPPING ECCENTRIC

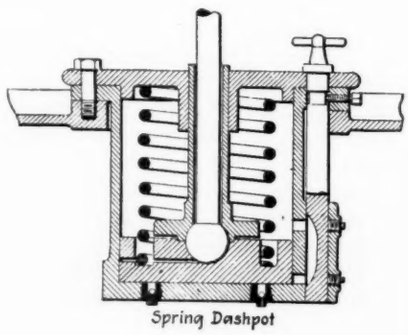


FIG. 4. SECTION OF SPRING-TYPE DASHPOT, NOTED FOR ITS RELIABILITY

To insure that the valves get dry steam, it is well to provide a separator in the steam line. A separator that may be made on the job by the engineer from material which may be on hand, is shown in Fig. 2. The drawing needs no explanation, as it carries the names of all parts necessary.

Power Plants That Are Ornamental As Well As Useful

Two Examples of Successful Efforts To Locate Power Plants in the Midst of Architecturally Beautiful Surroundings Without Spoiling the Picture

THAT the power or heating plant need not be an eyesore is proved in the case of two plants that have been constructed in San Francisco. The one shown in Fig. 1 was built in the Civic Center and was designed to harmonize with the new City Hall, Library and Civic Auditorium, and the State Building now under construction. This is a central heating plant and serves all the Civic-Center buildings. It is built of concrete and has no windows with the exception of a few small glasses in the doors, a skylight providing excellent light during the day. It is so constructed that two wings can be added in the future. The building shown in Fig. 2 is often mistaken for a museum or mauseleum, there being absolutely nothing to indicate that it is the central pumping station of the Spring Valley Water Co. It is located west of Twin Peaks in one of the most exclusive residential sections of San Francisco and, for the purpose of harmonizing with the surrounding residences, was designed with careful attention to its outside appearance. There is a beautiful fountain at each end of the building, where the circulating water from the condenser is cooled. On each side of the front entrance there is an artistic electric-light fixture, which presents a most pleasing appearance at night. Over the front entrance is an inscription reading, "Let Thy Fountains Be Dispersed Abroad and Rivers of Waters in the Streets," and an ornamental concrete casting is at the top of the building immediately above. There is not a single window in the structure, all light coming from a skylight. The interior of the engine room is shown in Fig. 3. The front entrance leads to the railed platform over the office shown at the left. From this point a visitor overlooks an interior as artistically designed and finished as the exterior. The boiler setting is faced with white glazed brick, as shown in Fig. 4. Since oil is used as fuel, there is no dirt from smoke or ashes and the machinery and interior are always kept spotlessly clean. Artificial light is provided by electric lamps in large glazed globes supported from the ceiling. There is a beautiful lawn in front of the station, and extending across the front of the yard is an artistic iron fence with large ornamental concrete posts at the ends. The old idea that a power plant is a nuisance to the community in which it is located is rapidly being abandoned as the public becomes more familiar with such examples as are shown here.

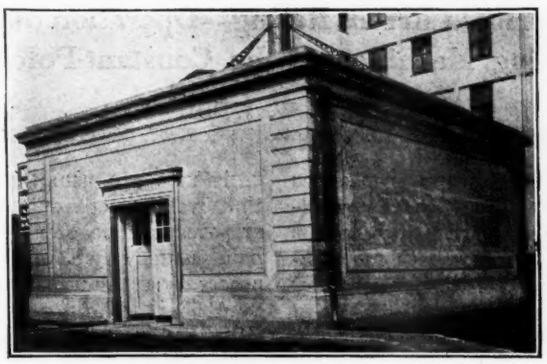
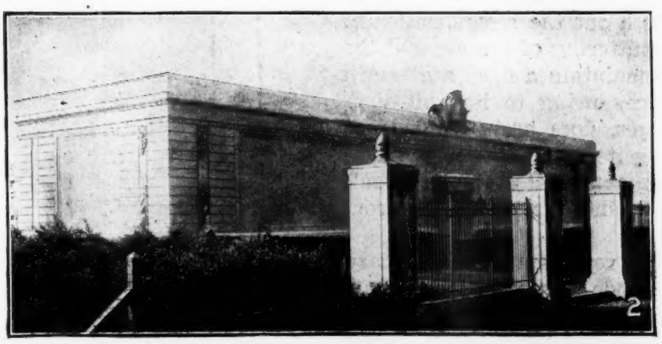
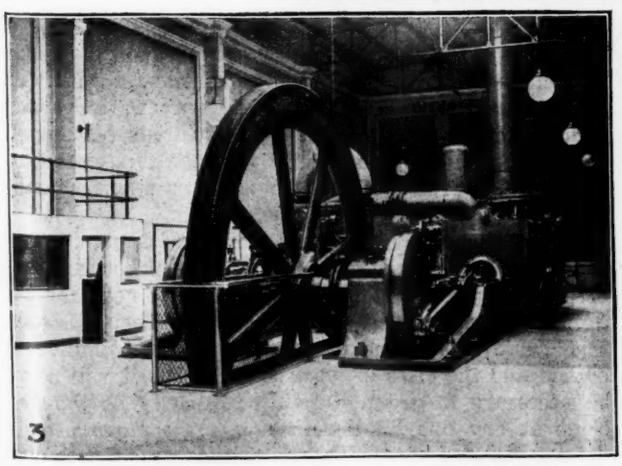
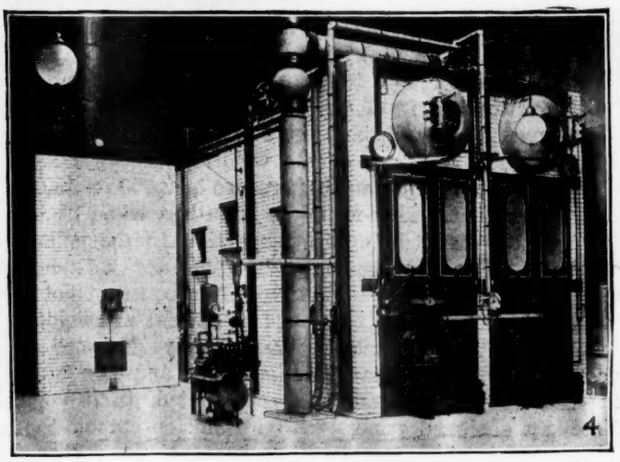


FIG. 1. SAN FRANCISCO CIVIC CENTER HEATING PLANT







SPRING VALLEY WATER COMPANY PUMPING STATION IN A RESIDENTIAL DISTRICT OF SAN FRANCISCO
Fig. 2—An exterior view of the station. Fig. 3—Interior view of the engine room. Fig. 4—Boiler room, showing glazed-brick settings

Electric Welding Machines—Direct-Current Constant-Potential Types*

Voltages and Efficiency of Welding Circuits—To Hold the Arc Reactance Is Necessary in the Welding Circuit—Machine Can Supply 40 to 50 Per Cent More Circuits Than Its Normal Current Rating—Operation of Different Makes of Welding Machines of the Constant-Potential Type

By L. W. WEBB
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WELDING machines normally group themselves into two main types, one for direct-current welding and the other for alternating-current welding. A large percentage of welding, both metallic-electrode and graphite or carbon-pencil, is done by direct current, with arc voltages approximately 20 volts for metallic arc and 38 to 45 volts for the graphite or carbon pencil. However, alternating currents can be used in many cases to equal advantage, but owing to the inherent low power factor of the welding circuits the application has been somewhat restricted.

In the elementary welding circuit with a metallic electrode, it is necessary to maintain a steady arc potential of approximately 20 volts. The earliest metallic-electrode welding was done from circuits of 550, 250 and 120 volts, by inserting a sufficient amount of resistance in series with the arc to limit the current to the proper value while maintaining approximately 20 volts at the arc. While satisfactory welding could be done with these higher voltages without the introduction of a reactance coil in the circuits, it was found desirable to insert reactances to smooth out the irregularities of the current caused by the sputtering of the arc and the inability of the operator to maintain a fixed arc length at all times. This reactance, owing to its ability to oppose rapid current changes, does assist in holding the arc stable and preventing its going out. The reactance also tends to prevent an abnormal rush of current, when first striking the arc, and the electrodes from sticking.

The wiring diagram, Fig. 1, represents an elementary direct-current metallic-electrode arc-welding circuit from a constant potential of 120 volts or higher. Taking a concrete example for the wiring diagram, using 100 amperes at 120 volts, the useful power output at the arc is found to be $20 \times 100 = 2{,}000$ watts, while the power output is $120 \times 100 = 12{,}000$ watts. This shows 10,000 watts lost in the resistances, lines, etc., which does no useful work and is dissipated in the form of heat. The efficiency of the welding operation from the power standpoint would therefore be $2{,}000 \div 12{,}000$ or $16\frac{2}{3}$ per cent. This would be even less when higher voltages are used, being in proportion to the voltage employed. For this reason special generators or motor-generators have been designed giving a constant potential from 60 to 75 volts for use as special arc-welding machines. These machines are usually designed to accommodate more than one operator and are often rated as high as 2,000 amperes at about 60 to 70 volts. Specially designed panels with a sufficient amount of resistance are usually supplied with the machines, so that welding currents varying from 60 or 80 to 200 amperes can be obtained as desired. Each individual panel usually contains, in addition to its resistance, the necessary reactance for properly taking care of welding conditions. The use of these machines also does away with the necessity of grounding the positive side of the line, as has to be done when welding from a 120-volt, or higher, power supply, except when the work is insulated from the ground. These sets can also be designed for use on any voltage or frequency by the proper selection of a suitable motor to drive the generator.

The number of operators a machine may be able to carry, due to the intermittent nature of welding, is at least 40 or 50 per cent more than the actual rating of the machine itself. The time consumed in changing electrodes, the natural fatigue of the operator and the making and breaking of the arc make the load factor of the circuit for welding about 50 or 60 per cent. Hence, a machine rated at 1,000 amperes continuous duty with 25 per cent overload capacity and 50 per cent momentary overload capacity could, without dangerous heating or sparking, accommodate at least ten operators, each normally using from 150 to 175 amperes when actually welding.

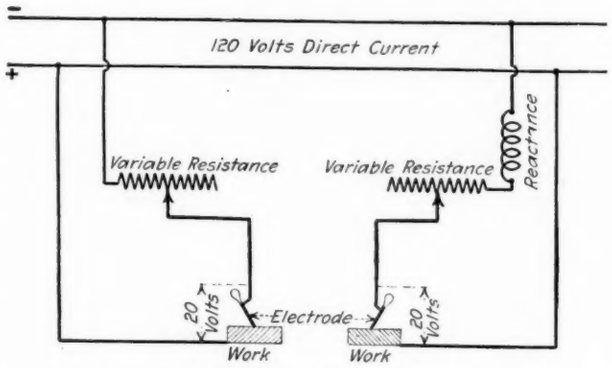


FIG. 1. ELEMENTARY WELDING CIRCUITS

These machines usually are wound with cumulative-compound fields, that keep the voltage either constant or about 5 per cent higher at full load to care for the drop in the feeders, etc. Where the shop layout is such that definite locations can be selected for individual outlets and the class of work is such that it will never be necessary to group the entire capacity of the machine at any one location, the generators are usually flat-compounded and individual circuits run to each outlet so calculated as to provide proper welding currents at this constant voltage. When the outlets are concen-

*Future articles by the same author will deal with constant-current types and with factors affecting the operation of electric welding machines.

rated, they are usually fed from a bus-feeder system and the generators are overcompounded to take care of the drop as the load increases.

Fig. 2 shows a simple wiring diagram of a generator and welding outlet. The over-all efficiency of these motor-generator sets, depending on the size, will be approximately 75 per cent. For the 60-volt sets the efficiency of energy delivered to the arc, as compared with the 120-volt welding at 100 amperes, would be as follows:

Watts delivered to arc equals volts $\times$ amperes $=$ $20 \times 100 = 2{,}000$; generator output in watts equals volts $\times$ amperes $= 60 \times 100 = 6{,}000$; and motor-generator input in watts equals output $\div$ (per cent efficiency $\div$ 100) $= 6{,}000 \div 0.75 = 8{,}000$. Watts used in the arc $\div$ motor-generator input $= 2{,}000 \div 8{,}000 = 25$ per cent, which is considerably higher than the $16\frac{2}{3}$ per cent efficiency for 120-volt circuit.

While the majority of these machines are designed for 60 or 75 volts, owing to the higher efficiency in regard to power consumption, lower-voltage machines of 50 down to 35 volts are furnished. It can be readily seen that the closer the voltage approaches the arc voltage of 20 volts the smaller losses there will be in the external resistance and the more efficient the welding operation becomes from the standpoint of power used. However, with voltages lower than 35 the maintenance of a stable arc is very difficult, by reason of the inability of the operator to hold a fixed arc length as the metal flows off the electrode to the work and also because of sputtering of the arc, etc. Even with 35-volt supply it is often very difficult to do reliable welding, especially on overhead work or where long leads are used when

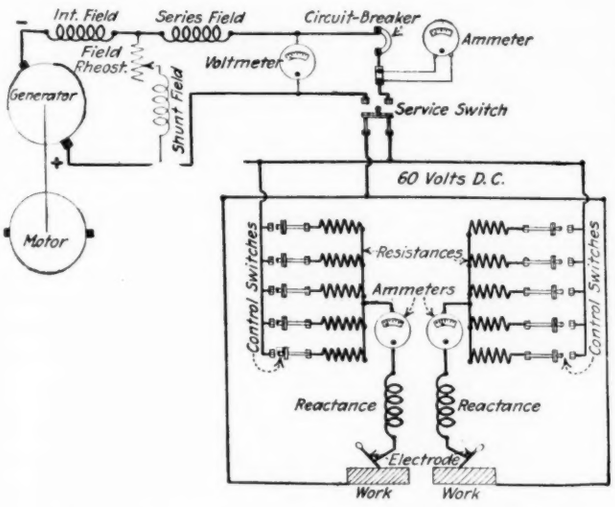


FIG. 2. WIRING DIAGRAM OF GENERATOR AND WELDING CIRCUIT

the work is a considerable distance from the source of supply. As the cost of power used is generally only a small part of the welding cost, it has been found in many cases that it is more economical to use a voltage not less than 60 on multiple-operator sets, especially where four to ten operators are supplied from the one machine. With the higher voltage there is less time lost due to the arc going out, and it is easier for the operator to hold the arc, since slight increases or decreases in arc length are accompanied by less current changes than with the lower voltages.

Multiple-operator sets, however, owing to their size and immobility, are really applicable only for stationary use at fixed centers of extensive welding activities. When it is necessary to provide machines for one operator, motor-generator outfits of the portable type or gas-engine-driven sets are preferable. These portable motor-generators or gas-engine-driven sets are sometimes constant-potential machines of 60 to 75 volts. However, specially designed machines of the so-called constant-current type are used to a large extent as

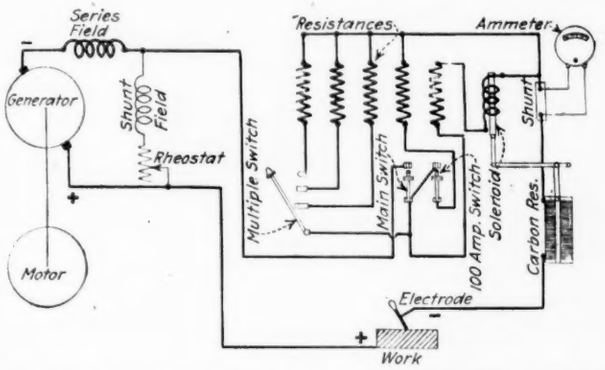


FIG. 3. WIRING DIAGRAM OF A LOW-VOLTAGE TYPE OF WELDING EQUIPMENT

portable machines. The machines, from an economical standpoint, as to over-all efficiency, are better suited than the 60- to 75-volt constant-potential machines, where the losses in the rheostat alone are approximately 50 to 60 per cent of the total energy input into the circuit.

With 60- to 75-volt constant-potential motor-generator sets of the multiple-operator type, the following advantages are claimed, as compared with an equal number of single-operator sets, the comparison being made between a machine capable of handling ten operators and ten single-operator motor-generator sets:

1. The first cost is lower, as well as lower depreciation and maintenance.

2. Simplicity and reliability of operation, as the machine can be permanently installed on stable foundations and requires very little attention or maintenance.

3. The over-all efficiency of the set is higher than that of ten single-operator machines, and the motor can be driven from 2,300-volt power, therefore doing away with a large part of line and conversion losses that the smaller machines would have.

The disadvantages, however, are that it is uneconomical, owing to the resistance losses in the welding circuits and to the fact that it is not easily portable and should be permanently installed to make it suitable for shop use, where the operators are relatively close to the machine. Also, as the number of operators working at any one time is reduced, the over-all efficiency of the machine is likewise reduced. There always exists the danger of grounding the wrong side of the generator to the work on the various outlets, especially when the work is being done on iron slab floors, etc., or a number of operators are working on the same piece of work.

A wiring diagram of the Wilson Welder and Metal Co.'s motor-generator is shown in Fig. 3. This is one of the lower-voltage, constant-potential types, for which

the manufacturer claims high efficiency, both in the use of power and welding ability, calling it the "plastic arc."

This machine operates normally at about 35 to 40 volts, and therefore the rheostatic losses are slight compared to those in the 60- and 75-volt constant-potential systems. The welding current is automatically controlled by means of a solenoid operating a carbon-pile resistance. This method of control enables the operator to hold constant heat at the point of application by holding the volt-amperes at the arc constant for each setting. In the earlier types of machines this carbon-pile resistance was made large enough to care for all voltage drop in the circuit, but on the later types there is furnished a grid-type resistance controlled by multiple-point switches for the larger current variations, the smaller current variations being handled by a smaller solenoid controlled carbon-pile resistance, claim being made that the arc inequalities are smoothed out much quicker in the new type than was possible in the older type.

The efficiency of the welding operation from a power standpoint for this type of equipment, on the basis of a 100-ampere welding current, is approximately 35 per

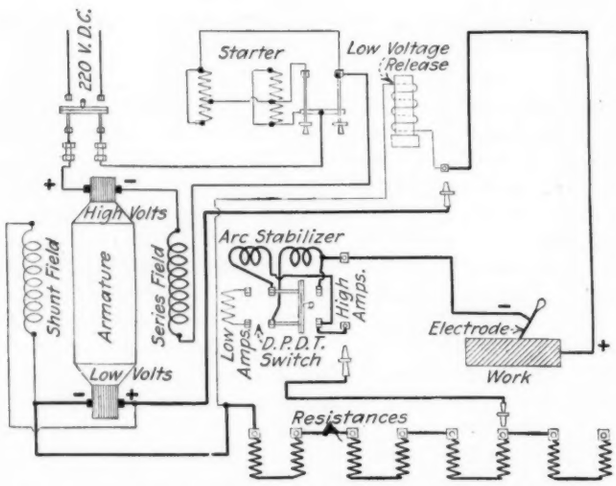


FIG. 4. WIRING DIAGRAM OF A DYNAMOTOR TYPE OF WELDING EQUIPMENT

cent, which is a relatively higher over-all efficiency than that of the 60-volt constant-potential set. However, there are found many places, especially where the work is far from the machines, where these machines will not work satisfactorily, owing to the lower voltage, and adjustments have to be made to the shunt fields to raise the voltage to approximately 50 or 55 volts; then the over-all efficiency is approximately the same as that of the 60-volt sets.

Although a separate reactance is not used in the welding circuit, the series winding of the solenoid which adjusts the carbon pile for current changes does supply the necessary reactance for stabilizing. It will be found that without this added reactance proper welding could not be done at 35 volts. The action of the solenoid regulating the carbon pile is as follows:

The welding current passing through the carbon pile and the solenoid winding when the arc is struck, creates a pull upward on the solenoid plunger. This slackens up the pressure on the carbon pile and allows it to expand, thus increasing the resistance in series with the arc, and prevents too high a rise of current at the moment the arc is struck. As the current thus tends to decrease, the amount of pull upward on the solenoid plunger likewise decreases, which allows the springs acting against the pull of this solenoid to again recompress the carbon pile, and causes the current to increase. The resultant forces between the spring compression on the carbons and the pull upward on the solenoid, as well as the heating up of the carbons, determines the final amount of compression of the pile, the resistance of same and final current. In the older type of panel this spring adjustment was made variable by the use of a small motor operating through gearing and controlled by the operator with a push button and separate wiring. On the latest type of panel the solenoid is the only means of automatic adjustment of the welding current while operating.

A wiring diagram of the Lincoln Bonding Co.'s dynamotor type of welding generator operating at about 50 to 55 volts constant potential is given in Fig. 4. Its main advantages over the motor-generator type are that it is extremely light and, therefore, particularly adapted for portable use, and it can be easily let down through small hatchways and carried about by two men. The over-all efficiency of this type of machine is also higher than that of the constant-potential motor-generator type of the same voltage rating. When operating under the same conditions as a motor-generator set, the efficiency of power input to total energy delivered to the arc would be approximately 15 to 20 per cent higher. The reactance coil or stabilizer on this machine is constructed so as to have two independent windings, and so connected to a double-pole, double-throw switch that when using low welding currents the coils are connected in series, giving high reactance, and when using the heavier welding currents the coils are connected in parallel, giving low reactance. This varying of the reactance has been found to be very advantageous, as it is especially desirable to have high reactance values with low welding currents, so that the arc can be easily maintained stable, and high reactance values are not necessary with the higher welding currents, as they allow too long an arc length with careless operators. The two armature windings on this machine are independent of each other, therefore its operation does not affect the supply circuit from which it is taken, as some other forms of dynamotors or balancers would. It has an accumulative wound field in series with the main-line current, which maintains practically constant voltage on the generator end with various loads, the shunt field being connected directly across the low-voltage armature without any rheostat in circuit. Experience has shown that good welding can be done with this machine with current ranging from approximately 100 to 225 amperes.

(*In the next article of this series, wiring diagrams of various types of so-called constant-current welding machines will be given and the operation of the machines explained. Comparisons will be made of the different methods of control.*)

A Correction

The article on "Circumferential Cracks in Crankshafts" published on page 45 of the July 13, 1920, issue of *Power*, under the signature of John F. Whitney, was contributed by John F. Whiteley, to whom it should have been credited.

Care and Maintenance of Fire-Prevention Systems—II

By C. H. JENKINS
Superintendent of Surveys, the Underwriters' Bureau, Middle and Southern States

A CONNECTION from the city water supply, where it can be used, makes a good source. The capacity is unlimited, and if the pressure is good the combination is desirable. Where in use, the pressure should be watched and at regular intervals drain-valve flowing tests made. With the drain valve wide open and a full 2-in. stream flowing, the pressure should not drop many pounds. An excessive drop indicates that something is wrong somewhere and should be followed up until found. Ordinarily, a drop of 10 to 20 lb. with an initial pressure of 60 to 70 lb. is not excessive. The gravity tank, Fig. 1, is considered one of the most reliable sources of supply. One advantage is that, unlike a city water connection or a pump, it is not dependent upon other apparatus for operation and is entirely under the control of the property owner. There are two features of maintenance which stand out as needing the most attention and giving the most trouble: If not properly watched, the water will get low or leak out entirely; the water easily freezes in cold weather if not kept warm.

The present method of filling tanks is to fill them through the main 6-in. or 8-in. down pipe. By doing this, the water goes in at the bottom and a clear waterway through the pipe and tank is assured. This is arranged for by placing a bypass around the check in the connection from the tank with a valve in it. By opening the valve, water can be forced around the check up into the tank.

If no high-pressure supply is connected to the system, it becomes necessary to install a special filling pump and connection. Water should be run into the tank at least once a week until it overflows. The overflow should be piped to a place where the water can be seen when it comes out. Though this is done, the tank should be climbed occasionally and examined. A case comes to mind where a tank showed full by an overflow test after the filling pipe had been opened only a few seconds. Upon examination, however, it was found that the tank was nearly empty. At some previous time, when it was full, two inches of ice had formed on top of the water. The filling pipe in this case was a separate pipe and fed in at the top. Each time the tank was overflowed, the water was simply poured in on top of the ice and in a short time ran out of the overflow. The main body of water, through evaporation and leakage, became lower and lower. No one knew what was happening. An examination of the tank disclosed the condition.

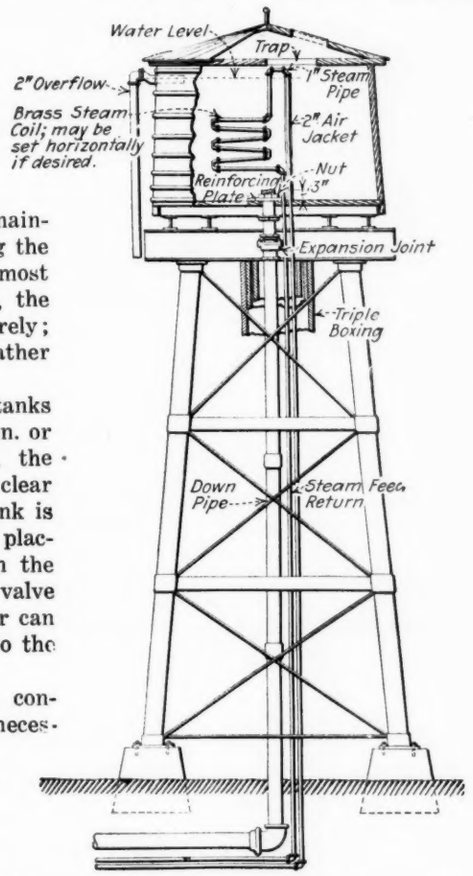


FIG. 1. THE GRAVITY TANK FOR SUPPLYING THE SPRINKLER SYSTEM WITH WATER

Hoops are often found broken or giving way. In one case, a new wooden tank, three hoops near the bottom were found broken, leaving the tank in a rather dangerous condition. They had evidently been drawn up too tight while the tank was dry, and when water was turned in the wood swelled, putting too much strain on them. For safety, if for no other reason, frequent examinations should be made.

The heating apparatus often gives trouble. A heavy layer of ice on top of a tank will at least impede the flow of water from it. It is probably a fact that a vacuum high enough to prevent water flowing out could not be obtained. Enough vacuum could probably exist to make the flow pulsating and uncertain and destroy the constant, steady pressure so desirable in fire-protection work. At any rate such a condition should not be allowed. The old-style heating arrangement was to carry a live-steam pipe up over the edge and into the tank. In cold weather live steam was occasionally turned into it and the water warmed. The sketch shows a brass coil set in the tank; this arrangement is better. The steam-feed line is carried up through the tank, sometimes through an air jacket formed by a 2-in. pipe made tight to the floor of the tank. This jacket prevents the steam from condensing too quickly, most of the condensation being formed when the steam reaches the down pipe or coil. This arrangement usually gives good results.

A much better method of heating, especially on tanks of moderate size, is the hot-water, circulating heater. It is shown in Fig. 2. It is only a small hot-water heater, the water warmed by a steam coil. It can be placed in a small shed under the tank trestle or in a building, but it should be located near the tank drop pipe. The inlet to the heater is taken from the 6-in. or 8-in. drop main from the tank. The outlet runs through a separate pipe directly into the tank and has several outlets at different levels. As the water warms in the heater, it naturally rises to the tank and cooler water is drawn to the heater from the drop pipe. This forms a circulation of warm water through tank and drop pipe. The heater can be turned on when cold

weather sets in and left on all winter. It must be examined occasionally to see that it is working right. Sometimes the trap does not carry off condensation from the steam coil and it becomes cold, or a valve may unaccountably become closed. With a moderate amount of attention they will not give much trouble.

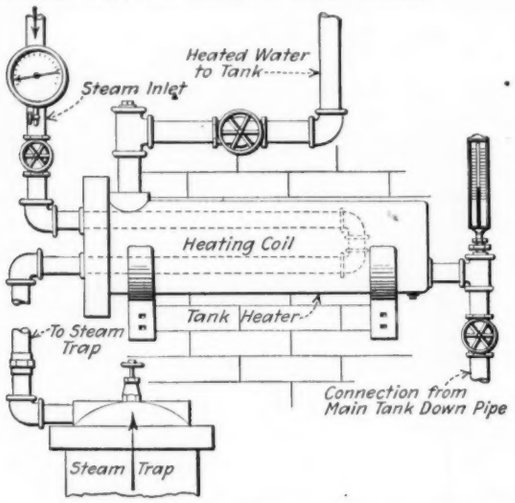


FIG. 2. THIS TYPE OF HEATER IS BETTER THAN THAT SHOWN IN FIG. 1

In moderate climates cypress or cedar makes the best tanks. If good spruce lumber free from knots can be obtained, it makes a good tank. In severely cold climates cypress does not seem to last. Tanks will last longer if not painted. There is, however, usually a desire to improve their appearance or to use them for signs. A moderate amount of paint on the outside does no particular harm, but they should not be painted inside. Steel tanks are being widely used, especially for the larger sizes. These should be kept well painted both inside and out. This is especially necessary if they are near sea water or exposed to steam exhausts. Steel trestles or supports need the same attention.

Tanks should be cleaned out occasionally, as there is sediment in most water which forms an appreciable deposit after several years. It is a good plan to have a telltale or indicator on the tank so that if anything goes wrong the height of water will be noticed at once. Do not place too much reliance on such a device. It should not be made the excuse for omitting a frequent examination. Often they get struck or do not work properly. Many little things, such as a drain valve not tightly closed, may empty a tank.

The pressure tank, Fig. 3, is a cylindrical steel tank made of boiler plate riveted. Two-thirds of the tank is filled with water and the other third with air under pressure; the usual pressure maintained is 75 lb. With a tank properly made and installed, it should not be necessary to pump air pressure more than once or twice a month. There are only two serious things that are likely to happen: An air leak may occur, or water may leak out somewhere through the system. On account of the rather high pressure a careful watch must be maintained. A small air leak will let the pressure down over night. The air gage should be watched and the water level frequently tested. The best plan is to visit the tank once a day. Ordinarily, it will be found all right, but if anything does go wrong the device gets out of service quickly.

On most gage glasses, for the purpose of testing the water level, there are two small valves, one at the bottom and one at the top of the glass, and two globe valves in each connection top and bottom. It is better to open the two small valves and leave them open, using the globe valves for testing. The small valves usually operate hard and begin to leak after a short time. Water should not be left in the gage glass. After testing the water level by opening the two globe valves, they should both be closed and the water drawn out of the glass by opening the small cock at the bottom. In testing, open the top valve first, letting air pressure into the glass.

Tanks should be kept painted with a good grade of lead paint both inside and out. If the water contains sediment, clean out the tank once in five or six years.

THE FIRE PUMP NEEDS ONLY ORDINARY CARE

Some engineers and mechanics look with more or less distrust upon the fire pump. To be sure, they are not the well-adjusted, smooth-moving machine that the steam engine is, but they are substantial and well built. It is all right, if necessary, to turn steam directly into a cold pump of the modern fire-pump type. For tests it is not recommended, but they are built to stand it if needed on short notice. They need only ordinary care. They should be turned over once a week and occasionally, say three or four times a year, run to pump water. They should be given oil frequently in all the working parts and a liberal supply of oil kept near-by. Look over the nuts and pins occasionally and see that they are properly adjusted. One loose key in the valve motion or rocker shaft may stop the pump when it is badly needed. Keep the packing at the piston rods fresh and in good condition. Always keep boiler steam

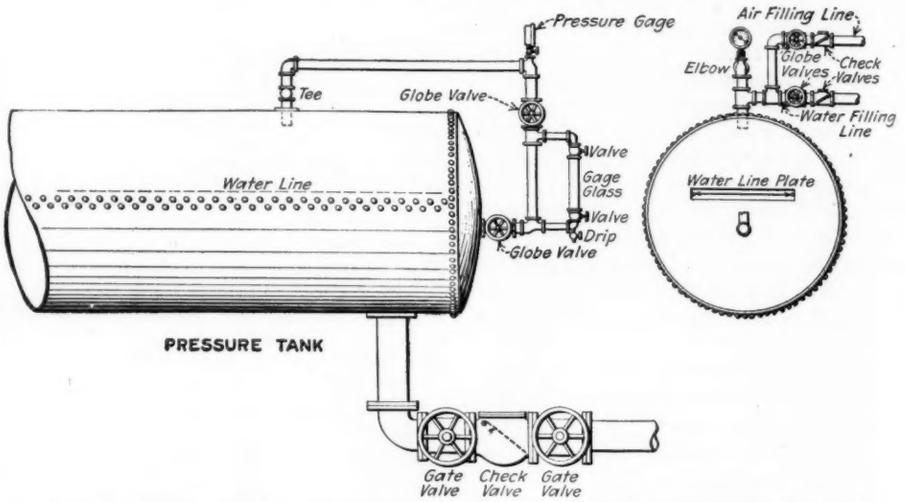


FIG. 3. THE PRESSURE TANK AS CONNECTED TO THE SPRINKLER SYSTEM

Weekly Inspection Report on Sprinkler Systems

LIST OF VALVES

NOTE.—All gate valves to be secured open with leather straps fastened with padlocks riveted or sealed. Padlocks, if used, to have common keys held by responsible parties. Each valve to be inspected by turning valve one-half turn to insure its being wide open and in good working order. Drain valves to be strapped closed in a similar manner.

No. 1. Location..... Open..... Secured.....
No. 2. Location..... Open..... Secured.....
No. 3. Location..... Open..... Secured.....
No. 4. Location..... Open..... Secured.....

COLD WEATHER VALVES

NOTE.—These control sprinklers in places which are cold in winter. In cold weather they must be kept shut (entry-ways, vestibules, etc.)

No. 5. Location..... Open..... Secured.....
No. 6. Location..... Open..... Secured.....

OUTSIDE VALVES

NOTE.—All post indicating gate valves to be fitted with handwheel or socket wrench permanently secured to spindle. To be secured and inspected in the same way as inside valves.

No. 7. Location..... Open..... Secured.....
No. 8. Location..... Open..... Secured.....
No. 9. Location..... Open..... Secured.....
Give numbers of any valves found closed, part closed, not strapped.....
Cause for condition found in?.....

DRY SYSTEMS (Air valves)

No. 1. Location..... Alarm conn. in order?..... Air pressure..... Condition.....
No. 2. Location..... Alarm conn. in order?..... Air pressure..... Condition.....
No. 3. Location..... Alarm conn. in order?..... Air pressure..... Condition.....
Give number of any air system not found in good order..... Cause for condition.....

ALARM VALVES

No. 1. Location..... Cock open..... Strapped..... Tested..... In order.....
No. 2. Location..... Cock open..... Strapped..... Tested..... In order.....
No. 3. Location..... Cock open..... Strapped..... Tested..... In order.....
Give numbers of any alarm devices out of service..... Cause.....

GRAVITY TANK Full?..... Contents frozen?..... Telltale in order?.....
PRESSURE TANK Water level?..... Air Pressure?.....

STEAM PUMP

NOTE.—Pumps should be given a thorough test with rated number of hose streams at least twice a year, spring and fall. They should be started once a week and water discharged through relief valve or otherwise to make certain pump is in order.

Valves in steam connection from boilers to pump wide open.
Minimum steam pressure for pump should be 50 lb.
Tested through.....hose streams. Condition..... Supply of oil on hand.....

ELECTRIC PUMP

NOTE.—Pumps should be given a thorough test with rated number of hose streams at least twice a year, spring and fall. They should be started once a week and water discharged through relief valve or otherwise to make certain pump is in order.

Any interruptions of current supply..... Condition of contact points on all switches.....
Automatic controller in order?..... Pressure maintained? .....

AUTOMATIC SPRINKLERS

Any corroded, bent, whitewashed, gilded or painted, covered with dirt or grease, obstructed by clothing, partitions, shaft hangers?.....

Is there a clear space of at least two feet below level of sprinklers, free from stored goods or other obstruction? .....

Note any exceptions.

IF DESIRED, OTHER GENERAL CONDITIONS CAN BE ADDED AS FOLLOWS:

INSIDE STANDPIPE AND HOSE

Water on pipe?..... Hose attached?..... Hose in good order?.....
Nozzles attached to hose..... Spanners handy?.....

FIRE PAILS In place?..... Full?.....

CHEMICAL EXTINGUISHERS

NOTE.—These should be used and recharged at least oncea year.

In place?..... Date tested and charged?.....

FIRE DOORS

Closed and fastened nights, Sundays and holidays and all times when not in use?.....
Will all fire-doors close easily?..... Note any fire-doors in need of repairs.....
Automatic attachments in order?.....

SHUTTERS

Closed and fastened nights, Sundays and holidays and all times when not in use?.....
Will all shutters close easily?..... Note any shutters in need of repairs.....

HYDRANTS AND HYDRANT HOUSES

NOTE.—Each hydrant should be given a thorough test by flushing at least twice a year, spring and fall. One turn to open should be sufficient at other inspections.

Hydrants open easily?..... Free from snow or ice and easily accessible?.....

HOSE, PLAY PIPES AND SPANNERS

In their proper place and ready for use? .....Condition? .....
(Each hose house can be numbered and reported upon separately.)

ELEVATOR AND STAIR DOORS OR TRAPS

In order and kept closed when not in use.
Note any exception..... Condition of latches or other hardware.....

CLEANLINESS

Oily waste well cared for?.....Basements clean?.....Yard kept free from combustible material?.....
Belt inclosures clean?.....Clothes closets and water closets clean?.....Shafting and bearings well cared for?.....Clean under benches?.....Note any suggestions as to possible improvements in cleanliness.

Date .....Signed .....

pressure right up to the throttle valve of the pump. As an auxiliary supply a fire-engine connection is usually attached to the supply lines at the street level. This is a 4-in. pipe with a check valve against the other supplies and two hose connections on the outside to which the fire department can connect its hose lines and pump into the sprinklers. These need little attention, except that in some localities it is difficult to keep the brass caps on the outlets. When the caps are off, it seems to be a favorite diversion for children to drop stones and other things down the pipes. Of course these may stop up the waterway. Cast or malleable iron caps can be used, as they have no value as junk and will probably be left in place. Water may sometimes leak past the check valve and get up into the connection. In cold weather it will freeze. On all such connections there should be a drip cock which can be tested occasionally.

Care of the Valves

The valves are one of the most important parts of a fire-protection system. If one is shut, water cannot get through to the sprinklers. Fig. 4 shows a common type of valve used on these systems. One advantage of this valve is that it indicates plainly whether it is open or shut. As shown, it is open. When being closed the stem moves, in, and when the valve is shut the end of the threaded stem is about level with the top of the yoke. When open, the stem projects out beyond the yoke a distance equal to about the diameter of the pipe.

To avoid having valves operated by ignorant or unauthorized persons, it is a good plan to seal or strap them open. This can be done by passing a light leather strap through the wheel, around the yoke and then riveting the ends together. In case of emergency the strap can be cut with a pocket knife. Instead of a strap a wire can be used and the ends fastened together with a seal. There are on the market some patented seals which cannot be used again if once fastened on the wire. An ordinary freight-car seal can be used. The wire, of course, should not be so heavy that it cannot be broken in a hurry. Sometimes straps and padlocks are used, and the keys left in charge of several reliable persons. The idea is not to fasten them securely, but rather that when a person sees a valve sealed in a certain way he will know that it should be left alone and will not tamper with it.

It is a good plan to have on the sealing device a tag with a statement printed on it that the valve is to be kept open.

In some establishments the valves are numbered, and in the office of the master mechanic or superintendent there is a row of pegs numbered to correspond, one for each valve. If it is necessary to close a valve, the tag, when removed, is hung on the peg with the corresponding number and stays there in plain sight until a new tag is given out and the valve reported open and sealed. The old tag can then be filed away or destroyed. This system prevents the valve being left shut after the men have finished working on the piping.

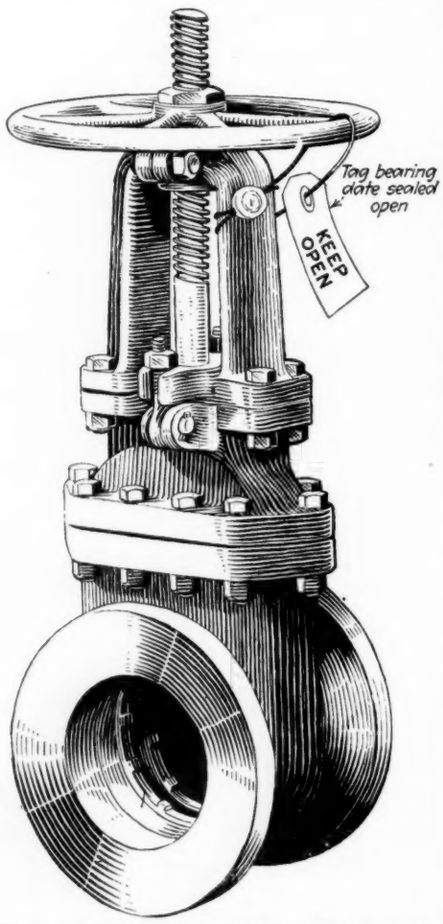


FIG. 4. THE VALVE OPENED AND SEALED

It may seem from the foregoing remarks that it requires a good deal of detailed inspection work to take care of a fire-protection system. But this is not so once the system is thoroughly understood. All necessary examinations can be made in one trip over the premises. Remember that thousands of dollars worth of property may be dependent, in case of fire, upon the fire-protection system.

Complete inspections should be made once a week. In doing this it is a great help to have an inspection blank or form to follow. With the different appliances all noted in order, nothing will be missed and no time will be lost in thinking about what to take up next. On page 215 is a general form suggesting a possible inspection blank. As shown, it deals with all the apparatus which could be used. In plants where there are no dry valves, alarm valves, or other such devices, the parts referring to them may be omitted. From this form a blank can be made up to suit any individual property and copies made for the mechanical man in charge.

[In many, if not most, factories the chief engineer of the power plant is also factory fire chief. The responsibility is no light one, even though state and municipal departments usually specify equipment and recommend procedure as to drills, constructions, exits, etc. The sprinkler system is the first aid source in case of fire, and to make pay the large investment which it constitutes, must be ready to function in all its parts at any time or season. Obviously, the chief engineer cannot personally attend to all the details; he must therefore select with consideration the subordinates with whom he shall share the responsibility. *Power* encourages its readers to pass this copy around to the men in the plant who have to do or may have to do with the sprinkler system, that they also may have the advantage of reading such a practical article on a subject about which so little is written from the point of view of the power-plant man.—Editor.]

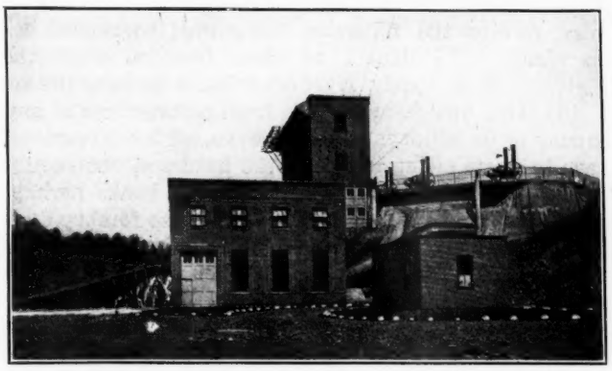
W. A. White, inventor of the low-pressure oil-feeding apparatus with which the White Star liner "Olympic" is equipped, offered to recondition the "Leviathan" and convert her into an oil burner for $10,000,000. He says there is one feeder the size of a pinhole for each of the 150 fires on the "Olympic," and fuel is sprayed by powerful fans after is has been heated to 180 degrees.

Effecting Efficient Operating Methods in Hydro-Electric Plants

The Result of Long Experience in a Number of Different Hydro-Electric Stations Located in Various Parts of the Country

By L. W. WYSS
Chief Operator, Twin Falls Station, Peninsula Power Company, Iron Mountain, Michigan

STREAM flow, load conditions, and reservoir capacity, together with other conditions, have an important bearing on the operation of hydro-electric stations. Operators must meet ever-changing conditions, selecting from day to day operating methods that will be of benefit to the system as a whole. There are, of course, many hydro plants where an expenditure for improvements would result in more efficient operation. However, the following methods may receive special considerations, as most of them do not call for any expenditure, but only operating vigilance.



TWIN FALLS STATION, PENINSULAR POWER COMPANY, IRON MOUNTAIN, MICH.

Because of correct design backed by experience, the safety of modern concrete dams is not jeopardized by carrying a higher headwater elevation than designed for. In view of this, when the station operators anticipate low water, every possible inch of storage should be obtained consistent with local conditions. The water may run over the top of flash boards or gates in such cases, but the extra storage may represent several tons of coal, which justifies breaking established precedents.

Use of Storage Reservoir

Even though the pondage is not large enough for seasonal storage, advantage can be taken of its limited capacity by loading the plant to lower the headwater in anticipation of spring floods or freshets, as well as for light-load periods which may exist each day from midnight until morning or on Sundays and holidays.

When work is done on a transmission line or any plant equipment which will curtail the station load, the pond should also be pulled to avoid wasting water if the total river flow is used.

Avoiding High Tail Water

At some plants during high-water periods the high tail water may curtail the station output. In such cases advantage may be taken of the light-load periods when full load cannot be obtained for the plant to waste all or part of the excess water. To accomplish this the headwater elevation is lowered during light loads and regained during the time that full load is available at the plant. To do this to advantage, the benefits derived from the lowered tail water must offset the disadvantage of low headwater, consequently plants with large reservoirs will be best adapted to this method of increasing the output while all turbine gates are wide open. When advantage is taken of storage water during low river flow and more than one reservoir is available, it may or may not be advisable to draw them proportionately. This matter should receive careful consideration. In the case of two plants of about the same capacity and effective heads, one may have double the storage of the other; this larger reservoir is the logical one to use storage water from, as a given amount of storage used will lower the larger pond only half as much as it would the smaller one.

If the dams were 34 ft. high and the smaller pond were drawn 4 ft., the station output would be curtailed approximately 12 to 15 per cent, while using the same amount of water through the turbines as with a full head. Using the same amount of storage water from the larger pond would pull the head only two feet, while the load would be curtailed only about 6 to 7 per cent, using the same amount of water through the turbines as with a full head.

When two or more hydro stations are operating on the same river, consideration should be given to the fact that any plant will receive the benefit of all storage reservoirs upstream. Before starting any additional or auxiliary steam equipment during low-water periods, it is well to analyze the situation thoroughly. Such analysis will often show that the water situation is not as seriously unfavorable as it appears, therefore, the extra steam equipment will remain idle and the hydro plants have a chance of pulling through the drought without help.

Value of Co-Operation

Co-operation of power-plant operators along a stream is beneficial even though the ownership of plants is not allied. The upstream plant with reservoir can, of course, take every benefit by using the water to best advantage unless compelled to give a certain steady flow for the downstream interests. Too often the latter plant owners demand river run, thus working a hardship on the upstream plant. An investigation may prove in some cases that steady river run from the upstream plant is not as beneficial for the downstream plant as co-operation with a view to handling the river flow for the mutual interests of all water users on the river.

When a power system is operating two or more plants and is required to discharge river run for other inter-

ests from a certain plant, which is usually the downstream plant, the river flow should be estimated and the operators at this plant given the authority to manipulate their governors to carry a steady load while the other plants hold the speed normal and take the major variations in load. This does not mean that the governors at the "river run" station fail to function so as to take care of load swings due to such fluctuating loads as railways, mine hoists, etc., but that a nearly constant hourly load be carried without the usual light-load periods which occur on most systems for a few hours at a time during weekdays, Sundays and holidays.

The downstream plants may receive the following benefits from the upstream plant: (1) Benefit of upstream storage reservoir, giving more steady river flow throughout the year. (2) The upstream plant may hold water back every Sunday or on holidays which the downstream user might have to waste owing to light load. This water can then be used to advantage during the working days. (3) When repairs are made to dams, gates, etc., the downstream plant may be aided by the upstream plant holding water back. (4) The upstream plant with reservoir capacity may be able to take the high peak out of a large flood which might in extreme cases prevent wrecking a defective downstream dam. The upstream plant can only receive concessions regarding the deviation of natural river flow, but this deviation may prove valuable.

Removing the Hazard of Carrying a Full Head in Winter

It is often necessary to keep the headwater elevation low during the severe winter months because all the waste gates are frozen fast, and it would take considerable time to chop them loose in the event of losing the load due to transmission-line failure. If the total river flowage is used, it will pay to avoid running with this low ineffective head by using one of the following methods of keeping gates free. (1) Employing one or more men to keep gates free; (2) use of steam or electric heating equipment; (3) use of compressed air to keep water bubbling and circulate the warmer water to the surface to prevent freezing; (4) circulating water with pump from the bottom of the dam to the surface.

Other means of wasting water in emergencies are to block the generators to prevent rotation while water is wasted through the turbine gates, or to use a water rheostat to load the generators, thus wasting water.

Preventing Ice Troubles

It has been found advisable at some hydro-electric plants troubled with anchor and frazil ice to shut down partly or completely to allow the intake channel to freeze over with ice, thus avoiding further troubles for the rest of the winter, as anchor and frazil ice do not form under an ice cover.

When protection cannot be obtained in this way, it may be necessary to remove the trash racks to operate at all when frazil ice is forming. The operating results of turbines should then be watched, and as soon as one is materially affected with clogging ice it should be taken out of service, the head gate closed and the turbine thawed out with steam. It will then be available for operation, after which another can be thawed out.

When troubled with frazil ice, it is a good idea to either have the racks totally submerged in the water or, in case they project, have the surrounding air heated, as either of these will help prevent the ice from sticking to the racks.

The most unfavorable conditions result from allowing trash racks to become so badly clogged that the elevation of the water is lower inside the racks than outside. This will lower the plant efficiency as well as the full-load output to a considerable extent; cases are known where this loss was over 10 per cent.

At some of the older installations having restricted trash-rack area with resultant excessive velocity through them, it may be advisable to install thin racks of curved horizontal cross-section in place of the thick iron installed when the plant was built. It is also advisable to have the forebay, penstocks or flumes free from obstructions of any kind. These obstructions may be caused by irresponsible persons dumping refuse in the headrace, obstructions left from construction work, caving of banks perhaps resulting from streams flowing into the forebay during rainy weather or from headgates not being completely open.

When the total river flow is used, all leaks in the dam should be stopped in some way. Most of these leaks appear at the waste gates, and perhaps new gaskets will be required. Cinders are best for stopping leaks. They can be dumped directly above the leaks, or guiding spouts can be made to carry them to difficult places.

Use of Governor Load Limiting Device

On an interconnected system the hydro-electric plant turbines should run with gate openings as near as possible to the high-efficiency point. It is hazardous to block the governors in this position, as a runaway would result from loss of load.

Some governors are provided with a load-limiting device which can be set to limit the turbine gate opening at any desired point. Primarily, these devices are designed to guard the generator from overloads when the effective head is at maximum. However, they find a wide field of usefulness when they are set to limit the gate opening at the most efficient point. The speed-control device is then adjusted so that regardless of small load fluctuations the governors will remain at rest. This will not prevent the governor from functioning properly in the event of loss of load. The value of this method can be appreciated when consideration is given the fact that maximum efficiency of most turbines is reached at about 0.85 to 0.9 gate opening, and that further opening results in a pronounced drop of efficiency. For dispatching reasons, or to keep a constant river flow for downstream plants, it may be necessary to run hydro turbines at constant loads; this is another service which the load-limiting device will render. It might be advisable in some cases to equip old governors with load-limiting devices.

Shall the Steam Stations Always Receive Favorable Load Conditions?

Load dispatching on interconnected systems is often such that the hydro-electric stations do not receive load conditions which enable them to run efficiently. This is principally because the steam-plant efficiency is given first consideration because the coal rate per kilowatt-hour is watched closely, and therefore the steam plants select loads suitable for high efficiency.

Looking at the matter from another angle, if the steam plants take the major load variations, thus allowing

the hydro-plant turbines to run near the high-efficiency point with sluggish governors or a load-limiting device, the additional load of which the hydro plants relieve the steam plants may save coal even though the steam-plant efficiency is lowered slightly.

Take a system of 500,000 kw.-hr. output per 24 hours. The hydro-electric turbines running at about 82 per cent efficiency deliver 250,000 kw.-hr. to the system. It may easily be possible to raise their efficiency to 90 per cent with favorable load conditions, in which case they could deliver about 274,000 kw.-hr. to the system instead of 250,000, using the same river flow. This would relieve the steam plants of 24,000 kw.-hr. each day, which would doubtless save considerable coal even though the diversity of load does not permit running as efficiently.

The steam-plant efficiency would not in most cases be lowered as much as the hydro-plant efficiency is raised, as the steam turbine has a relatively flat efficiency curve as compared with a water turbine, and modern methods of regulation enable the steam-plant crew to attain good efficiencies even though the load is not steady.

Some Hints Pertaining to Station Operation

If full load is available at a hydro-electric station during high-water seasons and the load is limited by the heating of the generators, it is, with few exceptions, advisable to make arrangements so that the turbines can run at full load. Perhaps it is wattless current heating the generators, in which case remedial measures may lie in correcting the power factor with available steam-driven generators, synchronous motors, or the installation of synchronous condensers. It may also be advisable to install ventilating equipment for the generators, or in extreme cases to rewind them for a higher kva. rating.

In stations that have a choice of either turbine-driven or motor-driven auxiliaries, the turbine-driven units should be given running preference over the motor drive during high water when the station is running fully loaded, while on the other hand, it is more efficient to run the motor-driven ones during low-water periods, as these small turbines waste water.

The maintenance of the power-plant machinery and switch gear should be attended to in such a manner that no equipment will ever be idle while load and water are available unless another hydro plant on the system can handle that load The maintenance of turbines should receive careful consideration. It is advisable to check their performance periodically. The quantity gage seems to be well adapted for these checks.

During Low-Water Periods

When tandem units are used, it may be advisable to open only the wicket gates of a part of the turbines on the lineshaft if that is possible, as higher efficiency will result. To insure efficient and reliable operation of hydro stations, the personnel of the operating force should receive careful attention.

It is true that steam stations are more complicated than hydro stations, but this does not necessarily mean that the hydro-electric station chief and operators have less responsibility, because the average hydro station has only one or two operators on shift and their individual responsibility is often greater than in a steam station where there are numerous men with divided responsibility. The hydro crew is often called upon to chop gates free of ice or to repair transmission lines under severe weather conditions. Also the hydro chief generally must maintain his plant in first-class condition without the help of skilled repair men, while the steam-plant chief has these besides boiler-room foremen, boiler inspectors and machine-shop facilities.

A Word on Specifications to the Refrigerating-Plant Operator

By B. E. Hill

A great mistake is made by prospective purchasers sending out for quotations on equipment intended to accomplish a certain result. For example, the writer had his attention brought forcibly to this some years ago in the purchase of a 100-ton double-pipe brine cooler to be installed in one of the Western plants of a large packing company.

Quotations were received from five of the leading manufacturers of double-pipe brine coolers, and the lowest of the five quotations, when compared with the cost per lineal foot of pipe per ton, was considerably higher than the other four, but as compared with the cost for a 100-ton brine cooler, the cost was considerably below the other quotations. The lowest bidder won. The writer, however, installed a brine tank and submerged the double-pipe brine cooler, connected the suction of the pump to the brine tank, discharged the brine into the double-pipe brine cooler and delivered it to the coils located in coolers containing meat products and returned the brine back to the brine tank, thus utilizing the double evaporating surface of the cooler inside and outside.

The objectionable part of this installation is the submerging of the pipe in a brine tank, which makes it more difficult to detect and repair leaks, but as the evaporating capacity is so greatly increased, the objectionable feature is absorbed.

In the purchase of equipment to obtain specific results, the engineer should write the specifications. For example, suppose a 100-ton ammonia condenser is required. The first thing to be considered is a location, next the available space which, if small, will limit the number of types to choose from, also the available water supply, its temperature, etc. After these details have been thoroughly gone over and the type of condenser required to do the work is decided upon, together with the size of pipe and lineal feet per ton of refrigeration necessary to hold the condensing pressure to the minimum, proceed to write specifications for quotations, stating the number of stands, number of pipes high in each stand, length of pipe, kind of pipe, how the joints and connections are to be made up, and if the stands are to be made up in sections at the manufacturers' works, being made up with split return bends and erected by the purchaser; how the headers are to be made, if they are to be extra heavy, connections screwed and welded, sweated or made up with litharge, style, type or make of valves to be used and, if possible, a blueprint covering all details of construction sent to the manufacturers.

This method of purchase places the manufacturers on an equal basis; they are all figuring on the same quality and quantity of material, which puts them on their merits and will prevent the skimping and skinning process that so often happens when the purchaser simply specifies an equipment to do a certain amount of work,

which in this case is a condenser capable of handling 100 tons of refrigeration.

One manufacturer may figure on wrought iron, another on steel, another on standard weight pipe, another on extra-heavy, etc., together with the numerous ways of making up these condensers; and still another will reduce the surface to such an extent that he will only "get by," by the "skin of his teeth" with a clean surface and new pipe, but when a little scale forms on the outside and oil accumulates on the inside, together with a collection of noncondensible gases, the water supply falls off, warms up or both, the boss will begin to complain on shortage of output, no efficiency, burning too much coal, using too much ammonia, and finally he decides he has a third-rate engineer. And maybe he is right.

The "live-wire" engineer must know what he wants and proceed to specify what is needed to get results. In nine cases out of ten, if he can half-way prove to the boss that he can spend ten dollars and get back fifteen in a reasonable length of time, the boss will spend the money. The engineer must first gain the confidence of his employer and to do this he must deliver the goods.

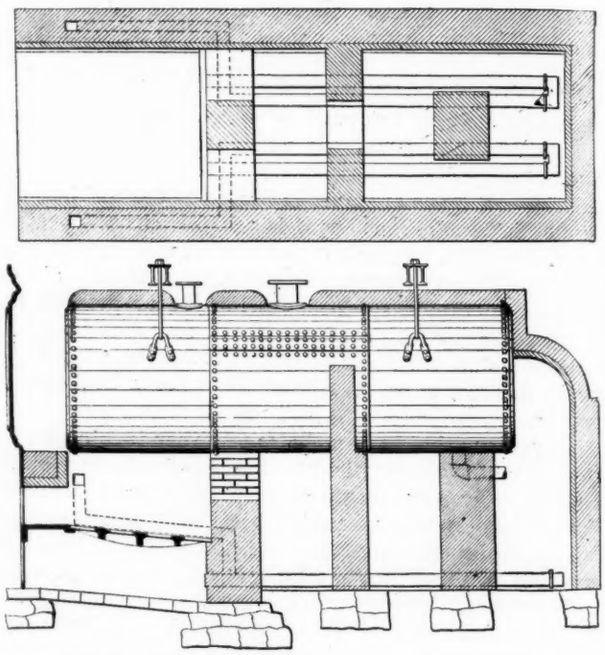
Preheated Air to Burn Volatile

Preheating a portion of the air required to burn the coal in a boiler furnace and admitting this air above the fire at a temperature sufficiently high to ignite the gases near the point of liberation, coupled with masonry construction to mix the gases and the preheated air, are the means employed toward securing smokeless combustion in the furnace designed and patented by I. W. Foltz, 175 West Jackson Boulevard, Chicago. Air is admitted to the ashpit as usual, and much of it passes up through the fuel bed. A portion of this air, 10 to 18 per cent, depending upon the resistance of the fuel bed, passes through an airtight channel or duct embedded in the floor of the combustion chamber. The entrance is at the face of the bridge wall if conditions are favorable, or in the side wall farther forward in the ashpit. The duct then comes out into the combustion-chamber floor back of the bridge wall, passes to the rear of the setting, returns by way of the bridge wall into the side wall, and then passes forward and out over the fire near the front of the furnace. A duct of this character made up of firebrick or tile and high-temperature cement, is placed on either side of the furnace.

In its passage through this duct it is claimed that the air is heated to temperatures of 750 deg. and above. By introducing this highly heated air at the point where it is most needed, it is possible to reduce the excess air passing through the fuel bed. This is accomplished by partly closing the damper, or preferably one of the ashpit doors. A high bridge wall with a pier at the center built up to the boiler shell, wing walls farther back and a pier in front of the blowoff connection, as shown in the accompanying illustration, are the means used to mix the gases and the air. In laying out the furnace, the grate surface, cubical contents of the combustion chamber, the flue area and the dimensions of the stack and breeching are all considered, but approximately, the openings over the bridge wall are 25 per cent greater than the flue area. The size of the duct depends upon the coal-burning capacity of the furnace.

One of the installations to which the foregoing applies was made in the plant of S. Karpen & Bros. Live steam is supplied for power purposes and process work by four 150-hp. return-tubular boilers, 72 in. x 18 ft., equipped with hand-fired inclined stokers having a 2-ft. coking arch and a single deflection arch back of the bridge wall. A smoke flue over the rear of the four boilers runs directly into a stack 66 in. in diameter at the top and 125 ft. high above the boiler-room floor. A draft of about 0.24 in. was available over the fire. Coal, hand-fired, was the principal fuel used. Recently, the coal obtainable has been of inferior quality, and its combustion was not improved by introducing on the top of the fuel bed the shavings and the wood refuse from the factory.

Normally, the four boilers, operated above rating, were needed to carry the load in winter and three in the summer months. The demand for steam was so urgent that it was difficult to burn sufficient fuel to carry the load. It was a question of forcing the boilers and smoking badly, which was the cause of constant trouble with the smoke department. The fires had to be cleaned



PLAN AND ELEVATION OF BOILER SETTING

three times on a shift of eight hours, there was trouble from large clinkers, and considerable unburned coal found its way into the ashpit.

In search of relief one of the furnaces was rebuilt after the design shown in the accompanying drawing, and shortly after, all four boilers were so equipped. The ducts on either side were made 5 in. square, and the brickwork within the furnace was rearranged as indicated. There have been no boiler tests, before and after, to show the results of the change, but improvement has been evident to the firemen.

Firing is lighter, there is no difficulty in carrying the load, and in the opinion of the chief engineer a reduction to two boilers during the summer would be possible if coal could be used exclusively as fuel. An intense fire is maintained with one ash door closed and the damper only partly open. The general improvement is attributed to more perfect combustion, complete burning of the volatile and reduction of excess air to a point approaching theoretical requirements.

Hydro-Electric Development, as Affected by the Recent Water-Power Legislation and the North Atlantic Super-Power Survey

THREE-FOURTHS of the possible 59 million horsepower of water power in the United States has been under Federal restrictions preventing its development, according to Franklin T. Griffith, of Portland, Ore., chairman of the National Electric Light Association's Committee on Water Power Development. A large part of the restrictions are removed by the new water-power law. Coal is jumping to undreamed-of prices and is extremely hard to get. It will unquestionably be higher and scarcer in the future. Every ton of coal that can be replaced by water power in making electricity will help ease the shortage.

To the person who lives in an apartment or home in the East, release of water power for his city means some measure of insurance against sudden darkness through delayed fuel shipments. In a few favored localities, sufficient hydro energy may be available to act as a slight buffer against steadily rising costs of making electricity from coal that often comes as high as ten to twenty dollars a ton. Indirectly, everyone benefits from more stable power for factories, street lighting, illumination of hotels, theatres and public buildings, and electric-railway operation. And all factories which make their own power from coal will be benefited by lessened pressure on the country's insufficient mining and transportation facilities.

One authority, Philip Torchio, of the New York Edison Co., figures that one-twelfth of the coal used outside of the far Western States in a recent year could be replaced by water power ($3\frac{3}{4}$ billion heat units from coal, 300 million possible from water power). As demands for power and light grow, the need for this hydro energy becomes greater.

New England and the Middle Atlantic States

In New England three-quarters of the possible water power is now utilized; comparatively little additional development is to be expected. A million and a half of the potential two million horsepower is developed. These figures credit Maine with generating equipment to care for three-quarters of her million water horsepower, and New Hampshire but 76,000 of her possible 295,000. Vermont has generating installations capable of developing 208,000 hp.—even more than her estimated 200,000 maximum potential horsepower which can be counted on for six months of the year.

Massachusetts also has facilities for handling a large part of her possible water power—268,000 of the estimated 375,000 maximum. Connecticut has 161,800 hp. in hydro installations, with 165,000 estimated possibility. Rhode Island is conceded but 16,000, of which she is using 12,700.

The United States Forest Service in 1912 estimated New England's water power maximum at 1,605,000 hp., while the Geological Survey in 1915 estimated 1,921,000, with equipment for generating 1,441,000.

New Jersey's hydro-electric installations have a capacity for producing 44,830 hp.; her maximum potential water energy is estimated at 125,000 hp., 35.8 per cent of which is cared for. Delaware and the District of Columbia have a possible 13,000 hp. each and have installations capable of developing 9,000 to 10,000 respectively. Maryland has 145,000 maximum potential water horsepower, and is utilizing 5,500 of this amount (The Geological Survey in 1915 estimated that 27,000 hp. was developed). Contemplated projects on the Susquehanna will give her 110,000 in addition.

Virginia has developed 201,000 of her potential million horsepower from water, and a 20,000-hp. project is planned on the New River. The maximum potential horsepower in each case represents the estimated amount of water power which can be assured during six months of the year.

New York State

New York State has developed more water power than any other state in the country, with installations of one million horsepower capacity and possibilities for three million. These figures are below those of the Geographical Survey estimate of 1915, which supposes a potential $4\frac{1}{2}$ million water horsepower, with 1,320,000 at work. She will, it seems certain, soon be surpassed by California, which is now a close second and can draw upon great sources of power in the mountains.

While some of the Empire State's water will be affected by the new Federal water-power law, yet state and international factors have greater bearing. The treaty with Canada restricting the amount of water that can be diverted from Niagara, and international regulations as to the St. Lawrence, are among the chief deterrents.

An electric power company executive who is quoted in the 1920 report of the National Electric Light Association's Committee on Water Power Development said:

> The bulk of New York State's undeveloped power, about 2 million horsepower, is on the international boundary streams—the Niagara and the St. Lawrence rivers—control over which is assumed by the Federal Government.
>
> Development of Niagara power is restricted by an international treaty limiting the diversion of water from the Niagara River to 20,000 cu.ft. per second, all of which is now utilized. The development of both the Niagara and St. Lawrence rivers is retarded by international questions.

Another New York utility executive says in the committee report:

> The ratio between the developed and undeveloped power in this state is particularly low in view of the great industrial development throughout the state, within easy transmitting distance of very attractive power sites. The reason for this is partly because a considerable portion of the undeveloped power is on the Niagara and St. Lawrence Rivers, ownership of which is disputed by the state and federal governments, and development of which is at present limited by international treaty.
>
> The development of power on streams which are neither interstate nor international boundaries has been hindered by the lack of suitable legislation to make such development possible. Although bills have been introduced in the legislature at nearly every session during the last twenty years, neither party has had sufficient majority over the other to succeed in enacting any constructive legislation which would definitely start development on either basis. What development there is has been effected entirely on private initiative by the process of buying riparian rights, one at a time, and at the seller's price.

Another New York central-station man points out that the larger portion of the undeveloped power from streams within the state is in, or connected with, the State Forest Reserves, which cannot be entered for practical purposes, without a change in the constitution of the state. General economical development of the power possibilities on other streams in New York State cannot be carried out without regulation of flow by reservoirs, to acquire lands for which will require the right of condemnation.

At Niagara Falls less than 10 per cent of the flow is available for power under the treaty with Canada. Of the flow of 210,000 cu.ft. per second, but 20,000 cu.ft. is used, although leading engineers have figured that 60 per cent, or 126,000 cu.ft. per second, could be used without detracting from the beauty of the falls. John L. Harper, chief engineer of the Niagara Falls Power Co., who has carefully studied the problem, says:

> To secure this diversion we have worked out a plan for placing concrete booms in the upper river so as to divert the water from the channel and spread it over the falls to cover completely the rocks that now show through at the edges because of the erosion and wearing away of the channel at the middle of the falls. By the diversion of 60 per cent of the river flow there would be available 3,600,000 hp., and the remaining 40 per cent under the conditions stated would not only discharge ice during winter, but improve the scenic beauty during summer.

The Far West

Federal legislation governing the use of public lands and reservations is of primary importance to the Western States, in which lie nearly all the public lands, and in which approximately 70 per cent of the undeveloped water power of the nation is found, it is reported by Mr. Griffith's N.E.L.A. water-power committee. In the Western States—California, Oregon, Washington, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming—94 per cent of the possible hydro energy is not yet used. Owing to delay of the construction program during the war, this section of the country finds itself today facing a situation ranging from actual shortage of power to meet demands as in California, to an impending shortage to meet growing demands as in Oregon and Washington.

California leads the Western States, even though far behind its needs, with a present development of 942,000 hp., which is a tenth of both the entire developed water power of the country and of California's possibilities. Her electric-power plants use no coal. Water and oil are employed for all her electricity. Washington shows the largest maximum potential water horsepower of any state in the Union, but it ranks among the Western States below both California and Montana in the amount of developed horsepower, 3.8 per cent of its possibilities. Idaho's entire supply of electricity, except a negligible amount from a few small isolated plants, comes from hydro plants.

The notable success in electrification of a large part of the Chicago, Milwaukee & St. Paul R.R. was facilitated by the use of inexhaustible, comparatively inexpensive water power of the Northwest.

North Atlantic Seaboard Super-Power Survey

One recent Washington development which may speed the utilization of Niagara and other sources of energy in the northeastern section is the provision for a Super-Power Survey, with an appropriation of $125,000, which went through with the Sundry Civil Expense Appropriation Bill, one of the last measures passed by Congress this year. It provides for a "special investigation of the possible economy of fuel, labor, and materials resulting from the use in the Boston-Washington industrial region of a comprehensive system for the generation and distribution of electricity to transportation lines and industries."

With any such movement to link up electrical lines, there will undoubtedly come strong pressure to employ to the maximum all available water power. Results obtained from similar projects in the West warrant most encouraging hopes for successful North Atlantic interconnection. One continuous trunk line extends from Southern Oregon, through California, to the Mexican border. Water furnishes the bulk of the power, and electricity is transmitted for great distances at high voltage. The highest-voltage transmission on record, according to the N.E.L.A. committee report, is 150,000 volts over a distance of 240 miles from Big Creek to Los Angeles. The longest high-voltage transmission is over 539 miles from Mono County, Califoria, to Yuma, Arizona, at 87,000 volts and 55,000 volts, by the Southern Sierras Power Co. The Pacific Gas and Electric Co. has in contemplation the building of a 220,000-volt line from its Pitt River plant into San Francisco, while other Western companies are planning similar lines for the near future.

These high voltages over considerable distances in the West show what might be done in the East if similar conditions obtained. The Southern Sierras' 539-mile line, for example, is about as long as the distance from Washington to Boston and nearly twice the distance in a straight line from Niagara to New York. But conditions are far different. All the electricity produced at Niagara or any other large generating center in the East could be used close to its source—if not now, at least within a few years. But if there were interconnection and New York City had a fuel panic, a serious emergency might be averted by temporarily drawing on Niagara. Or a source giving current for factories in Buffalo in daytime might turn out a night surplus which could help light the Great White Way.

The Super-Power Survey has been placed under the direction of William S. Murray, of New York City, consulting engineer, who will report to the Geological Survey. This movement is largely an outgrowth of the development which has been taking place for some years in central-station practice, where interconnection has been adopted whenever feasible in the interest of increased service from a given total plant cost, and of insurance against loss of service through interruption of any one station.

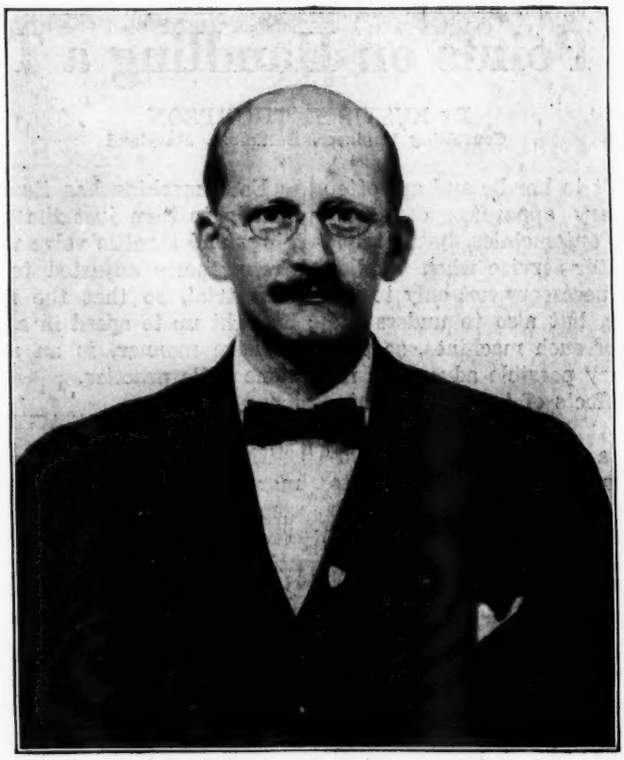
But 9,823,540 hp., or 16.6 per cent, of the country's maximum potential water power has been put to work. Coal and oil shortage and cost are certain to favor the rapid development of the "white coal," now that some governmental restrictions are removed and authorities in Washington are lending a charitable ear to the call of water. It is inexhaustible, except where deforestation cuts down regularity of flow of mountain streams; and the law which opens up water power on goverment reservations does not permit lumbering operations.

Many electric light and power producers, particularly in the East, have no streams to draw upon. But every company with available water power will take full advantage of any help the new law may give, in an effort to keep costs of making electricity from mounting to prohibitive heights.

An Expert in the Design of Large Power Stations

SEVERAL engineers were seated recently around a table in the dining room of the Engineers' Club, New York. One of them, a man of considerable prominence, told of a problem that was confronting his company in the matter of adopting certain designs, the solution of which depended upon a thorough technical investigation and analysis. He was in search of a consulting engineer qualified to solve the problem.

Instantly one of his companions replied: "Engage George Orrok. He will give you an engineering answer that you can feel assured is pretty near correct." The unanimous approval with which this suggestion was received by all those around the table indicated the standing of the man mentioned. George A. Orrok is one of a few men whose experience is closely interwoven with the development in design of the large central power station. Entering the field over twenty years ago as a draftsman for the New York Edison Co. at a time when the central-station industry was in its infancy, equipment was crude and inefficiency reigned supreme, Mr. Orrok applied himself to problems of plant design and was soon made chief draftsman. Recognition of his services came a few years later in his appointment as mechanical engineer of the company, and in this capacity he became closely associated with Thomas E. Murray, consulting engineer and vice president of the New York Edison Co. in the design of such notable power plants as the Waterside Stations of that company, the Two Hundred and First Street Station of the United Electric Light and Power Co., the Gold Street Station of the Brooklyn Edison Co., the Third Avenue and the Williamsburg Stations of the Brooklyn Rapid Transit Co. and the Hales Bar hydro-electric plant of the Chattanooga & Tennessee River Power Co.



GEORGE A. ORROK

Mr. Orrok's success is due to a real love of engineering. The road to success was by no means easy. Illness compelled him to give up his studies in the Massachusetts Institute of Technology in his junior year, and later, when he was actively engaged in the practice of his profession, he was again forced by illness to leave the work which he cherished. A few years in the country, however, aided by his indomitable will, brought back his health, and he was able to again take up a consulting practice.

His time was not entirely occupied in the construction of power plants, however. A variety of engineering work on the design of engines, boilers, condensers, turbines, dry docks, ships, etc., has also received his attention. He is well known in engineering circles as an author and lecturer and has contributed many articles to the technical press. His book on "Engineering of Power Plants," written in collaboration with Professor Fernald, is regarded as an authority on power-plant design. Mr. Orrok was born in Dorchester, Mass., in 1867 and attended the Mather School in that city and the School of Mechanic Arts. In 1885 he entered the Massachusetts Institute of Technology but, as previously mentioned, was forced to give up his college course on account of illness. After spending several months in surveying and investigating mining properties in Georgia, Tennessee and Wisconsin, he returned to Massachusetts and engaged in teaching at Bridgewater, West Springfield and Easthampton. In 1890 he left for Utah and taught for two years at the Ogden Military Academy and the Agricultural College. In 1892 he returned East and entered the employ of F. S. Pearson as draftsman and was engaged on work for the West End Street Railway, Dominion Coal Co., Metropolitan Street Railway Co., Brooklyn Heights Railway Co. and a number of others. He spent about two years in Nova Scotia as resident engineer in charge of construction on various kinds of work for the Dominion Coal Co., the

People's Light Heat and Power Co. and the Halifax Tramways Co., and in 1898 entered the employ of the New York Edison Co.

In 1910 he spent several months traveling through England, Scotland, France, Belgium and Germany on a study of the European engineering practice in connection with power plants and other work. From 1911 to 1914 Mr. Orrok held the position of Consulting Professor of Steam Engineering at the Brooklyn Polytechnic Institute, delivering two lectures every week. He also delivered a course of lectures on the Development of Power at the Sheffield Scientific School. He possesses a fine library of engineering and other books and spends much time in reading and studying. He is a member of the American Society of Mechanical Engineers, serving as Manager from 1911 to 1914; American Society of Civil Engineers; American Institute of Mining Engineers; Society of Naval Architects and Marine Engineers; past president of the Brooklyn Engineers Club, a member of the Technology Club and Engineers Club, of New York, and the Cosmos Club, of Washington, D. C.

Mr. Orrok's hobby is life in the country. He is an enthusiastic angler and camper and a student of nature, particularly of botany and bird life. At least two days of each week are spent on his farm in Connecticut, where he whips the stream for trout and tramps through the woods, keeping the sparkle in his eye and his body and mind in condition so that he can give to his work a full measure of energy and enthusiasm.

Operation and Adjustment of Turbine Machinery-IV
A Few Points on Handling a Turbine

By EUSTIS H. THOMPSON
Consulting Engineer, Baltimore, Maryland

TURBINES are not difficult to handle and are often simpler than the auxiliary apparatus connected with them. Like watches or automobiles, both simple to operate, they will give better service when handled in the proper manner. It is necessary not only to use care in starting and running, but also to understand the nature and peculiarities of such machines, so that they can be handled with every possible advantage instead of suffering from bad effects of improper manipulation.

It is often possible to start a machine without warming it up or opening the drains, and bring it up to speed rapidly. A small sized machine could stand such treatment for a while without perceptible effect, but a large, sensitive turbine would be sure to dance a jig that might end expensively.

There is some logic in not wasting time and energy in warming up and bringing to speed slowly, and we are naturally impatient of long, tedious processes. Few men who realize what the conditions are in starting up begrudge the time and care. Rapid heating means unequal expansion strains in the casing, which tend to strain joints and promote leakage. Drum-type rotors tend to run out of true when heated in one place by the steam; wheel hubs expand more rapidly than the shaft, so as to lighten their grip, while the hubs make contact from one to another, and in some cases tend to produce a spring in the shaft. Turbine wheels become distorted, and large diaphragms are liable to crack.

If the drain fails to carry off the water, vibration occurs and often actual damage results.

High-Speed Rotor a Sensitive Element

A spinning top can be picked up and tossed around when properly handled without disturbing its gyroscopic condition, but a misplaced touch would soon make it roll on the ground. A high-speed rotor is also a sensitive element and should not be subjected to sudden shocks of steam, water, change of speed or change of temperature. Always treat it with consideration, so that its balanced forces will not be taxed by any unusual strains.

Each machine has its own personal traits, and the ability to turn just the proper steam on the packing rings and throttle valve while the various other valves are properly adjusted to the correct amount at the first trial, so that the machine will be started and brought up to speed in a smooth, straightforward and positive manner, is an accomplishment that requires some little practice.

Study the Characteristics of the Machine

The "personal acquaintance" has its greater and more important use. Repairs and adjustments must sometimes be made quickly and well and often under conditions of high temperature, bad light and insufficient room. It is the man who knows where to find the proper tools and rigging; how to start the "inaccessible bolt;" where good fits and bad joints are encountered, that puts the job "over the top." Judgment and knowledge of the engineer come into play when it is necessary to keep the machine running with a hot main bearing or to decide how long a faulty governor can be trusted. Such duties can be executed by studying the characteristics of the machines.

An alternating-current generator is one of the simplest machines to handle. There are no delicate adjustments involved, and about the only duty outside of keeping the machine clean is to watch the brushes and see that they function properly. An alternator, like all other electrical machinery, becomes hot when overloaded, therefore the running temperature of the machine should be noted at intervals.

A direct-current generator which runs at several thousand revolutions is, on the other hand, a somewhat delicate piece of electrical machinery. Not many years ago it was regarded in the light of an impossibility to run such machines so fast. Such generators are now being turned out for some services and give the highest class of service. The secret of successful operation lies in the proper adjustment and design, which are done in the factory.

There is little danger that a machine which gives good operation will ever become unsatisfactory if

properly taken care of. The life of a machine lies in the brushes and commutator, and the engineer must inform himself regarding the proper grade of brushes and general treatment in operating. Most machines of this character are fitted with soft graphite brushes. Do not put oil or grease on a commutator with these brushes. Wiping the commutator with a clean canvas cloth is necessary only at long intervals. If the commutator becomes worn so as to start bad commutation, it should be ground to a true service without further delay.

Regular Inspections Should Be Made

While in regular operation it is seldom necessary to keep a man in constant attendance on each machine. Turbines are so automatic in their operation that actual attention is required only at long intervals. Some types will run for several days without actually requiring the touch of an operator. The engineer's presence is necessary in operating the turbine as a means of insuring reliability of operation. Maintaining the vacuum, watching the cooling water, bearing temperature and the action of the valve gear are the chief duties. The auxiliaries usually require more attention than the turbine itself. By making regular inspections at intervals of half an hour, one man can look after many machines. These inspections can often be duly scheduled and recorded with advantage.

It is the usual practice to clean thoroughly once a week; many machines are shut down on Sundays only and in some cases less frequently. Everything should be wiped out thoroughly and the brushes and packing glands and other small parts given attention.

Once a month the valve gear should be closely looked over, noting the points of wear. Trip the emergency valve by overspeeding. After the machine has been standing overnight or a similar interval, a quantity of oil should be drained from the lowest point of the oil system. The poorest-quality oil together with any water or sediment will thus be removed. If an amount equal to one-tenth of the contents of the oil system is thus drained off and replaced with new oil, results will be better than changing the entire amount of oil at six-months' intervals. In the former case the quality will be uniformly good instead of allowing it gradually to deteriorate. The oil strainer should be examined once a month. There is seldom sufficient dirt in the system to require cleaning so often, but the reason for this examination is that the presence of small particles of brass or babbitt metal will indicate that there is cutting of the gears or bearings before this condition would otherwise make itself known.

At this time each brush should be lifted from its holder and both holders and brushes wiped carefully. If the commutator slots are undercut, they should be cleaned if dirt is present. Cleaning should be done with a piece of wood or fiber—*never* use steel or other hard material, as it tends to roughen the edges of the bars. If dirt is not present, this operation is best omitted.

Once a year the strainer in the steam line should be inspected to see if there is danger of it rusting to such a point that it would crumble and come through to the turbine blades. The oil pipes should be removed and sediment cleaned from the system.

Valves, shaft packing, bearings and governors will usually give early and unmistakable signs when special attention is needed. The man on watch should report unusual behavior of such parts so that they can be attended to in time. Many conditions occur in operating that could not be enumerated. Many points that have been touched upon will be taken up later in a more thorough manner, as an extended treatment would be necessary to put them forward in a comprehensive way. In operating it is necessary to take full notice of all warnings or symptoms that the machine may give, and it will follow that keeping it in good condition is a matter of reasonable prevention rather than an elaborate cure.

Reminiscences of an Engineer

By W. D. Forbes

It has always seemed strange to me that so many steam engines have appeared, lasted a certain time and then become lost to view. The first small unit that impressed me (it is now out of the running) was the Peter Brotherhood three-cylinder engine. I first saw it about 1873 in Vienna; it made quite a stir in the engine world. The history of its design as it was told me by the nephew of Mr. Brotherhood some years ago is interesting. It is as follows:

While in church, the sermon not being interesting, Mr. Brotherhood fell to making sketches in a hymn book and drew the back of the head of a lady who sat just in front of him. Her hair was done up in three coils and when these were copied a cylinder was drawn in each coil and the original fundamental design of the engine was finished. This engine was made up of three 4-in. cylinders, set radially. It ran at a very high speed for its day, turning up to over six hundred revolutions per minute.

The workmanship was the finest I ever saw in an engine, and it had to be. The pistons were ground in, and the moving parts were of the same weight, making for balance. The cylinders were long, and the brasses on the crank end were made to cover a little less than one-sixth of the crankpin, they all meeting, of course, on the one common crankpin. The heating of these brasses was the only cause of trouble that I met in running any of this design of engine.

Wells' "Balanced" Engine

A year or two before the Centennial, 1876, a Mr. Wells built what he called a "balanced" engine. In the cylinder of this engine were two pistons. The one nearer the front end was fitted with two piston rods and connections having, of course, stuffing boxes, and the back piston had a single piston rod, which passed through a stuffing box in the front piston and through a second stuffing box in the cylinder head. The crank had three pins; two were connected with the rods of the front-end piston, and the pin between these two was connected to the rod of the back piston, the two outside pins being in line with each other and the third pin being in the same plane. This made it possible for the engine to catch on its center as would a single cylinder unit.

I ran an engine of this type, the first, I think, ever made, at over 600 r.p.m., while resting on a common deal table, and neither the table nor the engine was fastened down in any way, showing a fine balance indeed. Some years later Justin R. Wells took up the manufacture of this engine and quite a number

were sold; the last I saw was in the steam yacht "Giralda," and it was doing good work.

About this time, I believe, I was shown an engine in England which I was told ran 1,000 turns per minute. It was called the Tower spherical engine. I was not shown a drawing or told how the engine was designed, but drawings of it came out later in *Engineering*, of London. The engine was designed on the idea of supporting spheres at their central lines, with a segment cut from each which left a space for steam. This engine ran without noise and with almost no vibration, but it did not seem to take in the market as was hoped.

A small engine and boiler were put on the market in the middle seventies known as the Baxter. It was a most satisfactory combination and I think it was about as well designed a power plant as I ever saw. The engine was set on top of a vertical boiler, not in the usual way of being just perched thereon, but the cylinder was set vertically into the boiler with the result that the heat of the boiler kept the cylinder hot, which made for economy; in fact, it was a boiler-jacketed cylinder. I got very good results from one of these engines, so good in fact that the builders doubted the results at first. I think the engine and boiler were made in Paterson, N. J.

When the electric light came into being a number of horizontal engines appeared which were in some cases widely sold. The main trouble with about all of these electric-lighting engines was the governing, and some were made that were wonders to look at. One designer of these governors told me that all would work well in his shop, but not one would govern after being sold.

Before the electric-light era out West there were made, and perhaps still are made, the oil-well engine, and they were sold at a price that was so small that often they were left in the fields when a dry hole was drilled, as it did not pay to haul them to new fields over the very bad roads and rough country. These engines were a sight, decorated in a way that provoked mirth in those who knew fine engine work. For instance, the cylinder back head was supplied with rough nuts for the studs and these nuts were often gilded and decorated with pictures of ladies with the most remarkable physical developments.

The Straight-Line Engine

The "straight line" engine was a delight to see run, and it was more than a pleasure to go where it was made and meet that prince among men, Prof. John E. Sweet. Why this engine did not sell better is something which surprised many.

The number of freak engines that a man has seen who has been in the engine line for the last forty years would total a considerable figure. It was rather a poor week if at least one was not brought to an engine builder. Some of these were turned into other channels and did very good service as blowers or water meters.

Besides the various engines I have named there was a host of others, some of most excellent design and workmanship, which faded away, some because of poor management and others from lack of funds. Now we have the steam turbine, which is gaining ground all the time even in small sizes, although the economy of the latter is not all that is wished. Although the internal-combustion turbine does not look like a possibility, it would be a bold man who would say that anything in the mechanical line might not be accomplished.

I know there are many who consider steam as a back number for power, but if I had stock in a good boiler works I would not sell it just yet. In fact, I am of the opinion that we will see more and more boilers and steam engines used, and the advance, I expect, will be in the more economical use of fuel under the boiler and also a great advance in the steam engine whether it be of the old or new type.

As the cost of fuel rises we shall all have to cut corners as never before. There are small steam prime movers that are far more economical than those now used in this country, and only the cheap fuel obtainable here has kept them out of our market. However, with the advance in fuel cost these economical engine designs will find favor in the sight of the engineering world and purchasers will be willing, in fact forced, to buy these designs of coal-saving engines, but I know from my own experience that the American market will not take them despite their superior economy so long as cheap fuel is obtainable.

The Cross-Valve Engine

The readers of *Power* may be able to give some further information as to an engine which was most interesting to me away back in 1883 or 1884. I lost sight of it as I left Bridgeport soon after it was set up. The engine was built by a man named Webster and I think he called it "a cross-valve engine." The steam valves were set vertically on the side of the cylinder and they were of the Corliss type with some new idea of doing away with the dashpots. The exhaust valves were of the same type, but set horizontally; these valves were worked by the piston striking them, in fact by tappets. The steam valves were driven by an eccentric. The engine was horizontal and I think was supposed to be about 75 hp. and made some 60 r.p.m. The interesting thing about the design was that the two exhaust valves were placed so that when the piston was at the end of the stroke the valves were back of the piston.

This, then, was the idea of the present "Uniflow" engine. The steam entering at the crank end of the cylinder was exhausted at the back end of the cylinder, thus making a continuous flow of steam. At that time the late President Morton of Stevens was making city light tests and the Webster engine was one of those supplying power. Prof. Richards, of Yale, was indicating the engines of the lighting company and the Webster engine interested these gentlemen and several others. All objected to the system of actuating the exhaust valve, but the continuous-flow idea did not seem to interest any save a Mr. Wilmot, who was a manufacturer and not an engine man.

He liked the continuous flow idea and called on me several times with a view of my interesting some of my friends in experimenting further, but I left Bridgeport and as far as I know nothing further was done by Webster in engine building.

The difficulties in the way of providing proper lubrication for compressed-air machinery are largely due to the extreme high and low temperatures to which the lubricant is exposed, and, in the case of the compressor, to the fact that oil when in contact with heated air may deteriorate and become a source of trouble unless proper precautions are taken.

EDITORIALS

Overcoming The Cinder Nuisance

ANYONE who has had experience with large boilers that are operated much above rating is familiar with the cinder nuisance. Large quantities of half-burned particles of coal and some ash are carried by the high-velocity gases through the boilers and up the stack. These particles may be solid coal, but usually are more open and porous, like coke. The effect of this cinder shower on neighboring property is oftentimes serious and leads to suits in court. These cinders also increase the quantity of dust in adjacent streets and lead to unnecessarily high laundry bills. The cost of the cinder nuisance is often very indirect.

Many attempts have been made to install various forms of cinder catchers with more or less success. A few years ago *Power* described a wet-cinder catcher that was installed at the Waterside Station of the New York Edison Company. This was effective in catching cinders, but the metal parts were quickly corroded and the cooling of the chimney gases had a serious effect on the draft. The water was therefore cut off and the equipment used as a less-efficient cinder catcher. Various similar devices, consisting of baffles and cinder hoppers together with cyclone separators, have been tried with a measure of success in many plants.

However, all such dry catchers permit a certain amount of cinders to pass through and up the stack. The gases are diverted downward by placing a baffle in their path. The cinders are supposed to continue downward into the hopper, but to do so must pass through the current of gases, which now has an increased velocity in passing through the constricted area under the baffle. This stream of gases picks up a certain amount of the cinders and carries them along instead of allowing them to settle.

What promises to be a satisfactory cinder catcher is now being tried out in a New England plant. It is designed so that the cinders are properly separated from the gases and are allowed to drop into the cinder hoppers without getting into the gas current again. Furthermore, it is claimed that this new cinder separator causes less loss of draft than any of the older forms of baffles. Its performance will be watched with interest.

Cinders are removed in various ways from cinder hoppers. When gravity cannot be employed, possibly the steam-jet conveyor is the cheapest and simplest. These cinders are said to have a heat value per pound about fifty-five per cent of that of the coal used. They therefore form a low-grade fuel that should be utilized in the plant. In some places they are mixed with fresh coal and again fed into the furnace. It has been proposed to mix the cinders with some bituminous coal, to pulverize the mixture and to burn it as powdered coal under one of the boilers specially arranged for this purpose. This latter method may be possible in large stations, but in small plants the best plan seems to be to wet down the cinders and mix them in with the fresh coal.

Future Prospects of Increasing Thermal Efficiency

ONE of the great problems before the nations of the world today is the more economical production of power. Practically every civilized country is considering this question on what might be termed a national scale. Fuel is mounting higher and higher in cost and becoming more difficult to obtain, and since a very large percentage of power must be produced from fuel, it is paramount that the most economical means be employed in power production. With all of our boasted high efficiency in power-plant machinery and its operation, twenty per cent is about the best over-all thermal efficiency that is possible with our most economical turbo units. Seventeen or eighteen per cent is a fair average under the best operating conditions. Figures based on reports obtained from over three thousand central stations give an average of three pounds of coal per kilowatt-hour—the most economical plants are operating on about one and one-half pounds. Taking the figures for the most economical stations will give an over-all thermal efficiency for the plant from the coal pile to the switchboard of around fifteen or sixteen per cent. This being the case, the question naturally arises, What are the future prospects of increasing the thermal efficiency?

It has been estimated that with steam at three-hundred pounds, and five-hundred and twenty degrees superheat, used in a turbine operating on twenty-nine inches of vacuum and eighty per cent Rankine cycle efficiency, a kilowatt-hour may be produced on eight pounds of steam. Even this, which is a theoretical condition and not an average operating one, when it is possible of attainment, will utilize only about twenty-five per cent of the heat in the steam, which does not include the boiler-room losses. Experience with steam at seven-hundred degrees Fahrenheit indicates that very difficult mechanical problems must be solved before much higher temperatures can be used.

The tremendous heat losses in all central stations are in using the steam after it has been exhausted down to the pressure at which it goes to the condenser. From the temperature at which the steam enters the turbine down to exhaust pressure the thermal efficiency is nearly one hundred per cent. However, when we attempt to convert the heat in the low-pressure steam into power, the largest portion of it is thrown overboard in the circulating water. The problem therefore reduces itself to one of better utilizing the heat in the exhaust steam.

Where a turbine can be used between a high-pressure boiler and a low-pressure heating system, it operates at a thermal efficiency of approximately ninety-five per cent. This being so, and being done, why not apply this scheme wherever possible? If, instead of concentrating several large units in one great station in our large cities and industrial centers, these stations were divided up and distributed, in a number of locations advantageous for supplying a heating load in winter and

operating condensing in summer, for about seven months of the year the thermal efficiency of the turbines would be around ninety-five per cent. Even if for the remainder of the year the plant was operated condensing, the average yearly thermal efficiency would be raised from seventeen or eighteen per cent for straight condensing operation to forty or fifty, and probably higher, for the combined power and heating load. There is also the possibility, by a wide use of the absorption system of refrigeration, of using a large percentage of the exhaust steam the year round. Such a project would still allow the installation of units of the most economical size, but instead of being concentrated in one plant, they would be installed in several plants. These plants being tied together electrically as well as on the exhaust system, would require very little more reserve capacity than at the present time. Of course it is doubtful if heat and refrigeration could be supplied to any other than thickly settled communities and industrial centers. Even under these conditions the exhaust-steam requirements would exceed the demand for power.

In this project, as in any other, there is the all-important question of the increased revenue paying a reasonable return on the additional capital investment necessary to install and maintain heating equipment. This in certain districts has already been done, but the high price of coal has made possible the installation of fuel-saving means that a few years ago could not be considered from a financial standpoint. There is also the question of the heating load synchronizing with the power load. Experience teaches that no one particular method of power generation offers a complete solution of the problem of supplying cheap power. The proposition suggested in the foregoing, like all others, will have to be analyzed for each locality, but the possibilities it offers for fuel saving make it worthy of more serious consideration in the future than it has received in the past

There are tremendous possibilities for coal saving by electrifying our railways, developing our water powers, etc., but after this is all done our method of utilizing the heat in fuel will be just as uneconomical as it is now unless we adopt some method in power generation radically different from that employed in our large power stations at the present time, although this represents the highest development in the art. The problem of the future is not alone the economical utilization of power, but a more economical generation.

Electric Arc Welding Machines

ELECTRIC arc welding at present is in about the same state of development as the electrical industry was some twenty or twenty-five years ago; there are as many schemes for performing the same function as there are concerns manufacturing equipment, and each has its own advocates. In general, electric arc-welding equipment can be divided into two classes, constant-potential and constant-current machines, but the methods of applying these principles are numerous. This lack of standardization is due probably more to an absence of what the requirements actually are in a welding circuit than anything else. Although extensive experiments have cleared up many of the doubtful points, there are still many features open to discussion.

In its simpliest form an arc-welding circuit consists of a constant-potential source with sufficient resistance in the circuit to reduce the voltage at the arc to about twenty volts and also to stabilize the arc. However, such a scheme in general is inefficient on account of the losses in the resistance. To eliminate some of these losses and other features, many so-called variable-voltage constant-current generators have been developed. In these the terminal voltage automatically varies in an opposite sense to the current, to overcome the inherent unstable characteristics of the arc. There have also been developed a number of alternating schemes of both the constant-potential and constant-current types.

While all this development has been going on, the application of electric arc welding has been making tremendous strides, and at present welding machines have become part of many power-plant equipments; or, if not a part of the actual plant equipment, their use has become very general about the plant.

To give *Power* readers a general idea of the operation of a number of arc-welding machines that are now in use, a series of four articles, by L. W. Webb, will be published in this and subsequent issues. All the machines described possess advantages and disadvantages, which depend more upon local conditions as to their use than upon any merits or demerits in the individual machines themselves. One point brought out by Mr. Webb that is of particular interest is that supplying a large percentage of the power input of the machines at the arc should not alone be the deciding factor in selecting an equipment, as a machine operating at a considerably lower efficiency may show a lower cost of work produced than a machine of higher power efficiency, simply because its characteristics make it possible for the operator to do good welding at a higher rate.

Following Up on Repairs

THE importance of following up closely on power-plant maintenance work, also on inspections of equipment, is well shown in a brief paper elsewhere in this issue by Frederick L. Ray, for many years chief operating engineer in public-utility plants.

The author mentions, among other things, the timely renewal of steam-turbine blades. It happens that a turbine now and then loses a blade or part of a row without interrupting its service. The dismembered parts clear and fall away, doing no damage other than to the wheel to which they belonged. This is usually the case where the blades and diaphragms are sound and reasonably free from erosion. Turbine blades do not have to become considerably pitted to seriously impair the efficiency of the machine; if the edges, particularly, are "bitten away," as the operator aptly expresses it, the economy of the turbine is badly affected. If removed soon enough, such blades give little or no trouble and the cost of lowered efficiency does not become excessive.

Mr. Ray also calls attention to the importance of reasonably frequent inspections of the thread where the piston rod screws into the crosshead on old engines. The number of accidents from failures of these parts in the author's own experience, together with others, again directs the mind to the subject of fatigue of metals. The mechanical world is not getting the facts on fatigue fast enough. The slow failure, or weakening of metals in machinery and structures is of tremendous importance, and engineers must know more about it if they are going to control.

CORRESPONDENCE

Where Should the Beginner Start?

What has become of all the first-class firemen within the last five years? This I believe must be a pertinent question, considering the number of inquiries heard for some time past, and it leads one to consider the subject in its different phases.

I may have been more fortunate than others, judging by the many times I have heard, "Does anyone know where I can get a good fireman?" Because of the many complaints registered against men in the boiler room who claim to be firemen, and judging by some I have seen in different plants, I can readily believe that many of the complaints are justified.

I heard the chief of a large office building say that he would not allow a boiler to be cut in or out excepting when he was there to see that it was properly done, and that he found it necessary to oversee other details of operation that would have been subordinated to the firemen if they had been competent.

At a meeting of our association two members told of attempts made by their firemen to cut a dead boiler onto the line, one being frustrated by the timely appearance of the chief and the other by virtue of there being a non-return stop valve on the boiler. Another engineer told of his fireman removing the manhole dogs and trying to force in the manhole plate with 40 lb. pressure on the boiler. These men were hired as good firemen and were receiving the pay of first-class men.

Many of the younger firemen entered various branches of the service during the war, and many left to work in munition factories for the higher wages offered, but the bottom has dropped out of that industry and although we should be getting some of them back, they do not generally seem inclined to come.

I have had reasonably good success in breaking in likely young fellows who were interested in power-plant work and who were willing to study and learn, and I find that they can be readily molded into my ways and methods. New men must be broken in for power-plant work to take the places of those dropping out, and the question arises whether the new beginner should start in the boiler room, as at present, and advance to the engine room, or whether it would be better practice to start him in the engine room and advance him to the boiler room. It seems to me that the latter practice would be the better.

A young fellow entering the engine room first would be right in his element, if he is of the right sort. He likes to see the wheels turning and to start and stop the engines and operate the switchboard, all of which is pleasant and agreeable to a beginner.

In the engine room there is more to engage and hold his interest, and to him, the job looks more responsible and perhaps more dignified than shoveling coal and cleaning fires. This view of the situation, of course, is a fallacy, and he has yet to learn that the man with the scoop shovel, if he is a good fireman, is performing work that calls for better judgment and requires more experience to acquire the necessary results and efficiency than the engine-room work.

I believe that seven out of ten young fellows starting in the engine room would stick it through the boiler room, while not more than three out of ten starting in the boiler room would stick long enough to reach the engine room.

Many of our most successful engineers have started in the boiler room and by perseverance have risen to high positions; but the old order of things has changed materially with modern practice, and I believe this subject warrants consideration if we are to get and keep the right material with which to make the future engineers.

Considering another side, Is the beginner today worth more as a beginner in the engine room or the boiler room? The engine-room equipment has reached a high state of development and needs relatively little care or attention that cannot be delegated to a bright beginner under the supervision of the chief or a watch engineer.

Here he can gradually absorb a general knowledge as to the use of steam and its application in changing heat into work. He will also have an opportunity to study combustion and the generation of steam and will have ample chance to get the rudiments of boiler-room practice and the principles involved in the efficient burning of coal. Then, when he finally advances to the boiler room, it will be with a realization that he is being promoted, and he will be better able to appreciate the qualities necessary in the making of a first-class fireman.

The price of coal has steadily advanced to a point where careless and wasteful methods in its use are giving us all serious concern, and we must look to proficiency in the fireroom to keep this waste down to a minimum. One sure way to defeat this purpose is to put the coal pile in charge of inexperienced beginners. The duties assigned a beginner in the engine room do not present the opportunity for wastefulness, nor do they call for as much responsibility as in the boiler room.

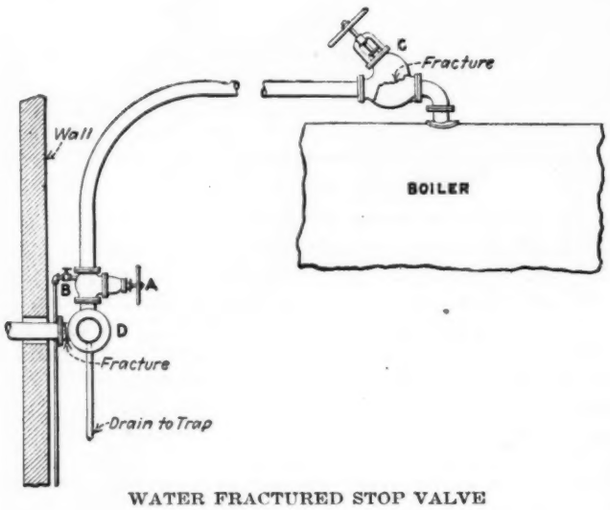
Given your choice between an experienced and an inexperienced fireman, which would you choose? If you had a position open for an oiler or engine-room attendant, would you hire an experienced operating engineer or break in a beginner?

J. A. LANE.

Windsor, Conn.

Water Hammer Fractured Valve

One morning recently a rather serious accident happened at the Vicksburg (Miss.) Light and Traction Co.'s plant. The operator was ordered to put in water and fire up No. 4 boiler. The 7-in. gate valve *A* had been closed in order to make some repairs on a 7-in.



WATER FRACTURED STOP VALVE

lead. The drain valve *B* was left shut. After the water was up to the proper height and before the fire was started, the operator opened the 7-in. gate valve *A*, neglecting to open the drain valve *B* first. About three minutes later a serious water hammer was heard and the automatic stop check valve *C* was fractured, as shown, throwing the top half, together with its bend, up through the roof and breaking off the neck of a 10 x 6-in. cast-iron tee that was bolted to the 10 x 7-in. tee.

Although no one was injured, it shows conclusively that it is dangerous to place valves in vertical lines, even though drains are provided. All the steam and water from the other boilers delivering steam to the 10-in. header *D* escaped through the breaks and the whole plant had to be closed down until repairs could be made.

H. T. FRYANT.

Memphis, Tenn.

Character of Sulphur Dioxide

An article by H. J. Macintire on refrigerants, in *Power*, June 8, page 914, has been called to my attention. I understand, of course, that Mr. Macintire merely attempts to hit a few of the high spots in his subject. Such brevity, however, invariably leads many writers into making general statements that may convey erroneous impressions. In his article I particularly refer to the sentence, "Sulphur dioxide and ammonia are deadly in small quantities if relief is not immediately obtained."

I am basing my right to be critical on my former experience as chief chemist for a concern manufacturing domestic electrical refrigerating machinery using sulphur dioxide as the refrigerating medium and my present work as production manager of a plant manufacturing anhydrous liquid sulphur dioxide. My reason for being critical is that I dislike to have wrong impressions disseminated about a chemical that has been condemned too freely, when my experience shows it to be quite well-behaved and not obnoxious to handle or work with. In fact, it is decidedly not a dangerous chemical.

To refer to the sentence quoted, it is not logical to put ammonia and sulphur dioxide in the same class. The use of the term "deadly" is rather sweeping and does not apply to sulphur dioxide. To the average reader the expression "small quantities" might mean anything. The last of the sentence, from the way it is worded and the apparent idea of the whole sentence, brings to mind immediately a picture of first-aid kits and stretchers. The author probably had good intentions, but this sentence is certainly misleading to a harmful degree.

I would appreciate hearing from Mr. Macintire regarding the points I have brought up.

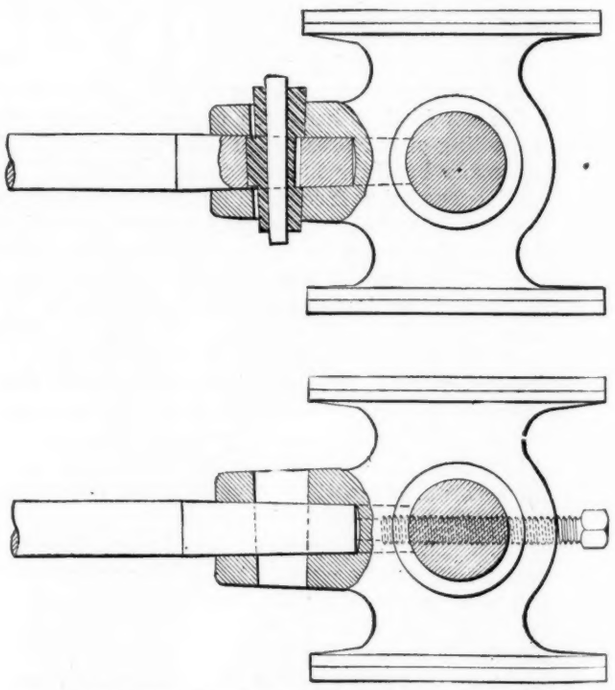
H. V. HIGHLEY,

Marinette, Wis. Ansul Chemical Co.

Removing a Tapered Piston from Crosshead

Loosening a piston rod from a crosshead, when a tapered end and key is used, as mentioned on page 897 of the June 1 issue, is sometimes more of an undertaking than one who has never had the work to do might realize.

At times it is necessary to heat the crosshead before the taper can be started, and then a special key and followers or gibs are used, as shown in the top view of the



TWO METHODS EMPLOYED IN REMOVING A TAPERED PISTON ROD

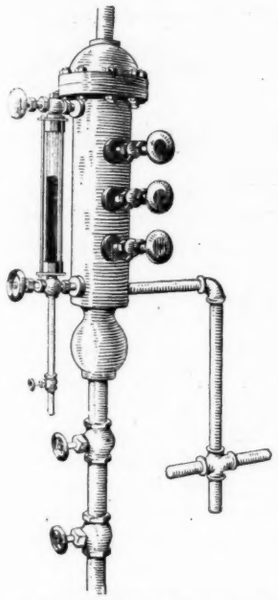
illustration. I have had to build a fire of waste and oil under a crosshead, of the double-guide type, carrying a 10-in. rod, and sledge the key with a 14-lb. hammer to start it.

On small engines we put in a false wristpin with hole tapped for a setscrew and start the rod with the jack so formed, as shown by the bottom view.

New York City. C. W. PETERS.

Plugs in Water-Column Connections

In the June 22 issue of *Power*, page 1014, Charles W. Carter, Jr., comments on my using brass plugs in water-column connections. In reply I would say that Mr. Carter is slightly misinformed. The water column in question was not connected to the boiler as illustrated, but as shown by the accompanying sketch. We always remove the plugs when washing out the boilers, and we find hardly enough dirt or sediment to soil the fingers. It will be observed that there are two globe valves in the water-column blow-off. I used to have but one valve with the consequence that when it began leaking, I could not put in a new disc or repair it until the boiler was shut down for washing out. In the meantime, if it was very bad I had to disconnect the pipe and plug it up or put in another valve below the one that was leaking. The last time it was necessary to use a second valve. I left it connected and have had no trouble since.



WATER COLUMN PIPING

Hasbrouck Heights, N. J. GEO. J. LITTLE.

Industrial Unrest

After reading Mr. Peters' article, "Industrial Unrest," in the issue of June 29, and reading again my article to which he refers, I cannot refrain from writing the following:

If Mr. Peters is working on his job sixteen hours a day it seems to me that a raise of 100 per cent in salary would be a very insignificant increase, as he is undoubtedly doing two men's work, as practically all fair-minded people, including those who go to make up the governing body of this country, have recognized eight hours as being the best and most logical duration for a work day.

He states that it is no farther to the "boss's" office than it is to his office. That is a fact, but after a man has gone to the boss's office two or three times and failed to get an audience, then the relative distance changes. I resent the inference that I may have been wanting in courtesy, as there is no statement in my article that justifies him in the assumption that I was or that I advocate such a thing. While I did not even hint that I went to any boss dirty, greasy or in filthy clothes, I will admit that I have done such a thing and was welcome, because the grime came from the performance of duty and it was necessary to go at that particular moment. As to going to him in my overalls that were "paid for," I have done that, and really expect to do it again, and can see nothing discourteous in doing it. They are my uniform, and there is no more reason for changing than there would be for a soldier putting on officers' clothes when he had to be in the presence of his superior.

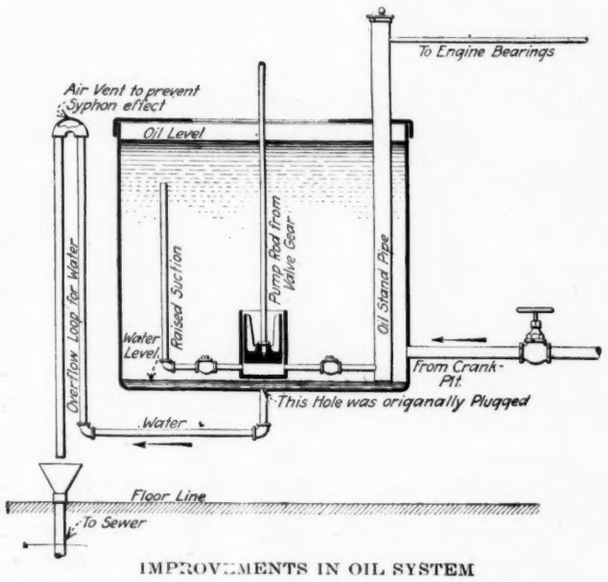
I am sorry that Mr. Peters overlooks the point I intended making, which was simply that there is not enough confidence between employee and employer and that, to a great extent, it is of the employee's making and could be easily remedied if the two would get together in a heart-to-heart talk. The illustration used was to show that when one has a chip on his shoulder it is easier to talk to the boss, and he will generally be found fair. After reading my article this is all that I can see in it, and as Mr. Peters says he wants the young men to see both sides of the issue I would be glad to have him tell what the other side from mine is, for his article does not present any other side that I can see.

I talk to my "boss" daily, not in overalls or with dirty hands or face, for I expect to wear overalls about as few times per year as any engineer in this city, but I contend that they are honorable, serviceable and very convenient. I also stick to the statement that a man is no better than he thinks he is; that "as a man thinketh in his heart, so is he"; and because a man by merit, pull or accident happens to be my superior in position does not make him my superior personally, and the right kind of "boss" is generally treated with courtesy in any event. H. A. CRANFORD.

Memphis, Tenn.

Improves an Oil System

Here is a sketch showing some improvements I made to an oiling system, which have given satisfaction for several years. The engine came equipped with an oiling system as shown by the sketch. The suction of the pump caught all the water and sediment and soon made an emulsion of the whole oil-tank contents. Every little while I had to change the oil, filter and separate out the old oil in a separate apparatus.



IMPROVEMENTS IN OIL SYSTEM

I raised the suction opening and added the complete overflow, and the water now flows out over the loop, carrying with it the sediment that settles to the bottom; while the raised suction gets the pure, best oil from near the surface. R. MANLY ORR.

Vancouver, B. C., Canada.

B.t.u. vs. Kilowatt-Hours per Ton of Coal as Measure of Efficiency

In commenting on power statistics issued by the United States Geological Survey, the writer, in the May 4 number of *Power*, took exception to the use of kilowatt-hours per ton of coal as the measure of station efficiency of public-service corporations furnishing miscellaneous services besides power. It was suggested that thermal efficiency be used as a measure of the station's economy or that public-service corporations be divided into two groups: One purely power service companies, the efficiency of which could be expressed in kilowatt-hours per ton of coal, and the other group stations furnishing power and other services for which some other standard might be adopted for efficiency measurement. An example was given to show that in the case of two plants, one furnishing power only and the other power and heat, the first could produce five times as many kilowatt-hours per ton as the second and yet be only one-fifth as efficient, when the comparison was made on the basis of the heat utilized.

It was stated also that the large differences in efficiency shown by the data furnished were not actual, the apparent difference being due largely to the standard adopted for measurement of station efficiency, kilowatt-hours per ton of coal, regardless of the kind of service furnished. R. S. McBride takes exception to the foregoing comment as follows:

> Mr. Misostow evidently was under a misapprehension as to certain facts with reference to these figures. He apparently believes that a considerable amount of fuel reported in these figures was used for purposes other than power production.
>
> As a matter of fact it is doubtful whether more than 10 per cent of the fuel used in any state by these companies reporting was consumed for such auxiliary uses as are mentioned in Mr. Misostow's comments. It seems very unlikely, therefore, that anything more than a negligible percentage of error could be introduced from this cause, even if all the companies reporting made the mistake of including in their reports all fuel, instead of only that fuel used for generating current. . . . There is no doubt that some of the exhaust is used for auxiliary purposes, but under the circumstances no large difference is probably caused by this fact.

The United States Geological Survey has done good work and has the public's confidence. The best intending public make use of the material published, and often for purposes entirely different from those for which the data have been collected. Data so furnished are expected to be impartial, adequate and entirely reliable, and in cases where the information is not as they wished it, due to no fault of the department, explanatory remarks should be furnished for the guidance of the public.

As no material could be more reliable or impartial than that furnished by the United States Geological Survey it is to be regretted that the data have not been compiled in such form as to be usable for establishing fuel cost per kilowatt-hour and for the establishment of rates, or in cases of emergency for apportioning fuel to the various public-service companies. Such data might also be used as a guide for directors of a corporation in judging of the ability of their engineer to utilize fuel to the advantage or disadvantage of the company.

As to super-stations (the significant future of which is only size and location) solving the power problem, this is an old dream, and a dream it will remain. The super-station of today will be a commonplace of tomorrow, as it has been in the past, but as long as the stations are built with condensers at one end and long transmission lines at the other we must continue to dream until these two monsters consuming the major part of the energy in the fuel are eliminated. Then a real and sane solution of the power production problem may be accomplished.

Chicago, Ill. HENRY MISOSTOW.

Burning Screenings Under Adverse Conditions

I have just read the editorial on "Burning Coal Under Emergency Conditions," in the July 20 issue of *Power*, and I hasten to tell your readers of a solution of such a problem in an Iowa city in a boiler plant having the McNillan furnace under return-tubular boilers, set about 54 in. from the grates, and with a chimney having a height of a ten-story office building. This plant has been using for years the local coal as found around Des Moines, and last winter during the coal shortage, when the Government directed to Iowa several thousand tons of anthracite screenings and buckwheat and also coke breeze, the engineers as well as the manufacturers in this part of the country were in a serious dilemma.

After many trials on the part of many good firemen, in this particular plant under discussion, there came one who wanted to try his hand at burning the anthracite screenings. As soon as he had seen the general construction of the furnace, he filled the side openings full to overflowing with the screenings and fired all the time through the front door, firing but one shovel of coal at a time, and that well spread. No failure in steam was noted, and the building was kept in operation continuously by the maintenance of a clean, clear, thin fire, using the shaking grates only slightly so as to remove the small amount of ash that resulted.

I wish someone would tell how to burn these coals with good results in marine types of boilers, also with water-tube boilers that are set high from the grates.

Cedar Rapids, Iowa. ROYAL H. HOLBROOK.

Cleaning Apparatus for Generator Winding

On page 878 of the June 1 issue of *Power* I noticed a description by F. C. Williams of a cleaning apparatus for generator windings. I wish to say that the apparatus as described by Mr. Williams is not only contrary to the rules of the Underwriters, but it is exceedingly dangerous to mix air and gasoline for such purposes.

A vapor of gasoline in air is highly explosive, and any flame such as might happen through sparking of the machine or through defective operation of controlling apparatus might cause an explosion costing far more than a first-class air-compressing outfit.

Chicago, Ill. H. E. WEIGHTMAN.

Do not assume the idea that the steam after passing through the engine is wasted. It is not, because it represents the largest percentage of heat delivered by the boiler, and much of the heat can be retained.

INQUIRIES OF GENERAL INTEREST

Disadvantages of Excessive Lap of Corliss Valves—What are the disadvantages of excessive lap on the steam valves of a Corliss engine? F. E. A.

Excessive lap reduces the rapidity and amount of movement of the valve at the point of opening, and also diminishes the range through which the engine will cut off.

Overtravel of Value—What is meant by overtravel of an engine valve? R. L.

The overtravel of a valve is the distance the outside edge of the valve passes by the inside edge of the port; or in other words, the amount of movement that takes place in excess of the movement necessary for completely uncovering the port.

Head and Back Pressure of Refrigeration System—What is meant by the head pressure and the back pressure of an ammonia compression system of refrigeration? H. B. C.

The head pressure in an ammonia system is the pressure at which the gas leaves the compressor. The back pressure is the pressure that is maintained in the expansion coils and the return system to the compressor.

Operation of Injector—How is an injector enabled to force feed water into a boiler and overcome the same or a greater pressure than the pressure of steam supplied to the injector? C. G. T.

The steam supplied in passing from the high pressure in the boiler to the low pressure in the injector chamber expands suddenly, and part of its heat energy is converted into energy of motion. When condensed by contact with the cool water the steam gives up part of its heat to raise the temperature of the water, but retains enough of its kinetic energy to carry along the water against the boiler pressure.

Isothermal and Adiabatic Expansion—What is isothermal expansion and adiabatic expansion? W. E. L.

When a gas expands it performs work. If expansion takes place at a constant temperature the gas is said to expand isothermally, and in order to have a constant temperature during expansion it is necessary to supply heat from some external source to compensate for the heat converted into work. This might be done in a steam engine by means of a steam jacket around the working cylinder.

A gas expanding in a non-conducting cylinder is said to expand adiabatically; that is, "no heat passing through," and its temperature will fall during the expansion, since no heat is supplied to take the place of that converted into work. This condition is probably never realized in practice, but is approximated when expansion takes place suddenly, as there is then little time for conduction of heat.

Equalizing Cutoff of Corliss Engine—How is the same point of cutoff obtained for opposite ends of the cylinder of a Corliss engine? C. R. T.

Make a mark on the crosshead and corresponding marks on a guide when the piston is at each end of its stroke, and another mark on the guide to indicate where the mark on the crosshead will stand when the piston is at one-quarter stroke from each end of the cylinder. With the wristplate hooked up and the governor blocked to the average running height, place the piston at one-quarter stroke from either end and adjust the length of the governor reach rod to the valve on the same end, so the valve will be just tripped when one-fourth stroke is reached. Then turn the engine over slowly and observe whether cutoff takes place as the piston is brought up to one-fourth stroke from the other end of the cylinder. If cutoff takes place too early, lengthen or shorten the governor reach rod to the valve of the same end so that it will not take place until after one-fourth stroke or if cutoff was found to take place too late, gradually adjust the length of the reach rod so the valve is just tripped when the piston is brought up to one-fourth stroke. If there is a single reach rod from the governor with a link connection between the valves, adjustment should first be made of the rod that has direct connection with the governor. When adjustments are made, test the equality of cutoff when the governor is blocked a little higher and also when blocked a little lower. On account of variation of angular position of the governor connections, it is impossible to make adjustment that will obtain exact equalization for all positions of the governor, but when made for any particular position, equalization for the average load can be made by adjusting the cutoff of one end of the cylinder checked by indicator diagrams.

Horsepower Constant of Engine—What is the horsepower constant of an engine having a cylinder 22½ in. in diameter and 42-in. stroke with piston rod 3 in. in diameter and running 85 r.p.m.? W. L. G.

The horsepower constant for each end of the cylinder is the number of indicated horsepower developed by 1 lb. mean effective pressure, and therefore, to express horsepower constant, the usual formula

$$hp. = \frac{P \times L \times A \times N}{33{,}000}, \text{ becomes } hp.\ c. = \frac{1 \times L \times A \times N}{33{,}000}$$

By substitution, the horsepower constant for the head end of a 22½ x 42-in. engine, running 85 r.p.m., is found to be

$$hp.\ c. = \frac{1 \times \frac{42}{12} \times 22\tfrac{1}{2} \times 22\tfrac{1}{2} \times 0.7854 \times 85}{33{,}000}$$

$$= 3.584 \textit{ hp. per lb.m.e.p. for H end.}$$

Allowing for a 3-in. diameter piston rod, the horsepower constant of the crank end is found to be

$$hp.\ c. = \frac{1 \times \left[\frac{42}{12} \times (22\tfrac{1}{2} \times 22\tfrac{1}{2}) - (3 \times 3)\right]}{33{,}000} \times 0.7854 \times 85$$

$$= 3.52 \textit{ hp. per lb.m.e.p. for C end.}$$

The h.p.c. for use with the average of the m.e.p.'s of both ends would be, 3.584 + 3.52 = 7.104 hp. per lb. average m.e.p. of both ends.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Experience in Power-Plant Operation*

By Frederick L. Ray†

Accidents cannot always be prevented, for hidden defects will develop to the breaking point before they can be detected. Proper inspection, however, will prevent most accidents, and careful planning for the future will eliminate 90 per cent of what inspection fails to find.

The cost of maintenance work can be lessened by doing the work before the life of the material is gone; but a great cost can be burdened on a property by replacing machinery just because it has been in service for a certain number of years. We are justified in replacing the axles of the high-speed interurban cars after they have been in service for a given number of miles, for we know by experience that there is an average life of an axle beyond which we should not go because of the danger to life and property if they should break, but we would not be justified in replacing all the tubes of a boiler just because they have been in service twenty years, for they may give many more years of service. Even if one should give way, it seldom results in more than the loss of the one tube.

The renewal of a few rows of blading in a turbine at an expense of, say, $2,000 may easily prevent an accident in which perhaps it will ruin all of the blading and cost many thousands of dollars, with possible interruption of service.

How much better it is to take a boiler off at stated intervals, thoroughly testing, cleaning and repairing so that when it goes on it will be in first-class order, than to keep operating it until the efficiency drops to 30 per cent or a tube splits wide open, with possible loss of life and interruption to service.

Belts for Ash Handling

There have been many installations of belts for the handling of ashes, but in my experience every installation has been a failure. One that I have in mind is where there were sixteen boilers. A system of 24-in. wide belts was put in to deliver the ashes to an elevator. This system consisted of five different belts, four of them running parallel with the boilers and delivering to a cross-belt which delivered to the elevator. This system was operated about one year, then discarded, and the wheelbarrow used in its place. During the period of operation about $7,000 worth of belts were used with about 30 per cent efficiency in labor while operating the belts. There was excessive maintenance of other parts in the few months' use of this system, besides the belts, so that all together it was an expensive experiment.

The chief trouble with the system was to keep men from pulling hot ashes on the belt. Many methods of quenching the ashes were tried, but in spite of all we could do by threats and discharges, the men would burn the belts so that in a short time they had to be renewed. While we were working on the belts or machinery, the laborers would be idle, waiting for the system to start. Sometimes the basement would be nearly full of ashes, and then it would take several days to get cleaned up again.

On account of the small capacity of the ashpits it was necessary to use two crews, night and day, on this work, which required about twenty-five men. After the belts were taken out and wheelbarrows used, we decided to get more capacity in the ashpits. The capacity was increased to a twenty-four-hour run, after which one crew of nine men took care of all the ash handling, using wheelbarrows, where formerly we had twenty-five men on the belt system.

Another serious trouble here was the burning of stoker dump grates because of the shallow ashpits and the failure of the belt conveyor. As the capacity of the ashpits was increased and the method of handling ashes made more efficient, this trouble disappeared.

Engine Crosshead Failures

Cast-iron crossheads on engines that have been in service for fifteen to twenty years should be closely watched, for there is likely to be a failure of the threads in the crossheads where the piston rod screws in.

On taking charge of some old engines, I have found conditions that were startling. One illustration will suffice. On an engine of 26-in. diameter cylinder operating at 150 lb. steam pressure we found the threads in the crosshead practically broken off, just a few threads holding, so that the least shock from water or foreign matter would have stripped the rod out of the crosshead, with the result that we would have had a serious engine wreck and possibly loss of life. Piston rods should be screwed out of the crosshead often enough to make sure that they are in good condition.

Condenser Suction Pipe

Long lines of suction piping on jet condensers often cause considerable trouble with the pumps attached to this line, as a small leak of air into this line will cause serious trouble. I have had two systems of piping that were the cause of much trouble. One of these lines was a 20-in. riveted sheet-iron pipe with wrought-steel flanges partly under ground but about one-half of it exposed in the basement and in close quarters. To this line four marine-type jet condensers were connected. As soon as we began to have trouble with the condensers, our first thought was of the suction line, and there we usually found the trouble.

In another plant there were five marine-type jet condensers connected on to an underground suction line made up of bell and spigot pipe with lead-packed joints. We could not get any of the condensers to work satisfactorially. Investigation was started, and before we completed the work we had dug up, calked and packed every joint on this pipe. After this was done and the condensers overhauled they would pull the required vacuum without any trouble.

Our method of discovering the leaks was to put in a blind flange as close to the source of water supply as possible, and by having a water connection we could pump up about 40 lb. pressure on the line and keep on making these tests until everything tested tight. The suction pipe to any kind of a pump should be tight, but where it is used for condenser purposes it must always be kept very tight..

Feed-Water Treatment

Water for boiler purposes should be as pure as it is possible to get it; in fact, distilled water would be best. Water softeners, either hot or cold process, will give water that will enable a plant to operate satisfactorily, even with a very bad water before treatment. Care must be exercised in starting a softening plant where the boiler has been in service a number of years using bad water, for every time the water is started in too soft the scale will be thrown from the tubes and great damage done by burning them.

As an illustration, a softening system had been operating for some time, using a certain amount of lime and soda ash to take care of a creek water. It happened that it rained for about a week, with the result that the hardness in the creek was reduced considerably, but there was no change in the amount of lime and soda ash used. The water was therefore made very soft with a surplus of soda ash going into the boilers, which resulted in throwing down much scale which lodged in the lower tubes, a large number of which were burned and several boilers put out of commission, interrupting service.

The remedy was to stop the treatment for several days. The tube trouble was stopped. Water-softening systems are like everything else about power plants—they must be closely watched by someone experienced in their operation.

Increasing Capacity of Ashpits

In a certain plant I found the ashpits under a chain-grate stoker with capacity for only about four hours' run. Two crews of men were needed to handle coal and ashes, one day and one night, working ten-hour shifts. These ashpits were worked over so that the capacity was increased to a thirteen-hour run. After the change was made a crew of eight men and a foreman did all the work in a ten-hour shift, saving the wages of seven men. This is a case where the saving in labor paid for the cost of making the improvement in four months' operation.

*From a paper before the Central Station Electric Association.
†Union Traction Company of Indiana.

Record of Large Turbo-Generator Armature Breakdowns*

By F. D. NEWBURY
Manager Power Engineering Department, Westinghouse Electric and Manufacturing Company

THE following statement is a complete record of armature breakdowns that have occurred in Westinghouse turbo-generators of 15,000 kva. or larger polyphase rating. The record covers every turbo-generator of this size that had been placed in operation up to January, 1920, by this company. These generators, without exception, are mica insulated, with mica insulation between the strands and between conductors as well as between coil and core.

The first of this company's generators larger than 10,000 kva. were placed in operation in 1913. These machines were of approximately 20,000 kva. capacity, two-pole in the case of 25 cycles and four-pole in the case of 60 cycles. The design of such large two- and four-pole units in 1911 and 1912 was highly experimental, and while these units met the standard temperature-rise guarantee of 50 deg. C. by thermometer, it has since been found that the true copper temperatures of the strands nearest the air gap at the center of the core have been at least 200 deg. C. rise in some cases. Experience has shown designers how to avoid these high local temperatures to a considerable degree (mainly by reduction of eddy-current losses), and this is mentioned here only to bring out the significance of the record of trouble due to heating.

It is also important to note the inclusive and representative nature of the record. It covers all generators built of a given size and type, and it is therefore safe to draw general conclusions that will be applicable to all generators of the same class.

During these seven years' experience there have been 22 cases of major armature trouble involving 12 different installations or designs and 16 individual units. By major armature trouble is meant trouble serious enough to result in the failure of one or more armature coils.

The classification of armature failures as to cause is in some cases a difficult matter. The events leading up to the trouble may be unknown, and the evidence is very often burnt up. It has been thought best, therefore, to separate these cases into three classes as follows: (1) Where the manufacturer has accepted responsibility; (2) where the operating company has accepted responsibility; (3) where the cause is unknown or in dispute.

1. Eight cases were chargeable to design, workmanship or other cause for which the manufacturer accepted responsibility.

(a) 5 cases (of these 8) were caused by defects in manufacture that developed shortly after installation.

(b) 3 cases (of these 8) concerned details of design that led to failure after four or five years' operation. Two of these cases (in one design) involved high local temperatures caused by eddy currents in the top strands of the coil.

2. Eleven cases were chargeable to operating hazards for which the operating company accepted the responsibility.

(a) 4 cases (of these 11) were caused by fire originating outside of the armature winding. In three of these cases the fire started in the cables just outside of the generator; in the fourth case the fire started in a series transformer accidentally open-circuited.

(b) 4 cases (of these 11) occurred in one installation and were caused by abnormal voltage surges that caused the outside surfaces of the insulation to catch fire. In addition to these four cases that resulted in coil failures, as many more fires started that were put out before such damage was done. This trouble disappeared after the generator neutral was grounded.

(c) 1 case (of these 11) was caused by ice or water carried into the generator from the air washer.

(d) 2 cases (of these 11) were caused by enforced operation under conditions that were known to be unsafe. One case involved unsafe overloads and the other case involved continued operation after it was known that the armature needed minor repairs.

3. Three cases involved unknown causes or the cause was in dispute. In two of these cases the operating company believed armature-coil heating to be responsible.

This classification of armature breakdowns shows that out of 19 cases, where causes were agreed to, 11 cases were caused by operating hazards for which the generator can in no way be held accountable. The majority of these cases were caused by fires of external origin.

If all of the cases in which armature heating was involved (even by suspicion) are grouped, there are only 5 cases out of 22 breakdowns. Two cases (involving one of the first designs) were caused by design proportions; in two others temperature was not the primary cause of breakdown, but the operating companies believed it to be a contributory cause; and in the fifth case enforced overloading was the primary cause.

The writer's opinion, based on a careful study of operating experience and a detailed knowledge of internal temperatures and coil and insulation design, is that breakdowns caused by armature heating are in reality due to abnormal local temperatures that have values of the order of several hundred degrees; and that temperatures of 100 deg. or 150 deg. ordinarily discussed in connection with guarantees have very little to do with the problem. This statement, of course, applies only to windings completely insulated with mica within the slots.

High-Voltage Machines Reliable

This record of breakdowns brings to the surface another fact that is interesting and important and that is reassuring to the companies operating high-voltage units. If these generators be classified according to voltage, it is found that there are twice as many generators wound for 11,000 volts or higher voltage as there are generators wound for lower voltages. But these twenty-two cases of armature breakdown are equally divided between these two voltage classes. This means that the percentage of armature breakdowns in the high-voltage generators under discussion is only one-half that of the lower-voltage machines. This record would be very different with treated-cloth insulation (in large high-voltage generators) that is subject to cumulative heating on account of dielectric losses increasing with temperature; or with partially closed armature slots, still used by some European designers.

This record does not prove that high-voltage generators are necessarily safer or less subject to breakdown, except in so far as breakdowns may be caused by voltage surges that are independent of generator voltage. Obviously, a 10,000-volt surge would be dangerous in a 2,400-volt generator, but would be harmless in a 13,000-volt winding. The record does prove that 11,000- and 13,000-volt windings are just as reliable as low-voltage windings and, further, that breakdowns are generally caused by trouble unrelated to line voltage.

The facts brought out by this record may be summarized as follows:

1. The majority of armature breakdowns are caused by operating hazard originating outside the generator.

2. Armature heating in armatures completely insulated with mica is a minor cause of breakdown.

3. High-voltage generators, with mica insulation and open armature slots, are as reliable and probably are more reliable than large, low-voltage generators.

*This article is based on a discussion of a paper, "Classification of Large Steam Turbo-Generator Failures," by Philip Torchio, presented at the A.I.E.E. convention, White Sulphur Springs, June 30, 1920, and published in *Power*, July 13, page 76.

Federal Power Commission Plans Detailed Organization

Plans for the detailed organization of the Federal Power Commission were agreed upon at a meeting of the commission in Washington July 27. The commission will be composed of the following subdivisions: Engineering, accounting, statistical, regulatory, licensing, legal and operation. The engineer officer is to be in immediate charge of the engineering division, with the title of chief engineer of the commission. For purposes of administration the country has been divided into five districts.

District No. 1 will have its headquarters in Washington and will consist roughly of the territory east of the eastern shore of Lake Michigan, the Illinois-Indiana boundary and east of a line drawn so as to include the Ohio River basin and proceeding irregularly southward to the Gulf at Mobile.

District No. 2 has its headquarters at St. Paul and includes that territory west from District No. 1 to midway in the Dakotas and north of Muscatine, on the Mississippi, and Sioux City, on the Missouri.

District No. 3 has its headquarters at St. Louis. It includes the Mississippi basin south of District No. 2, and all of Kansas, Missouri, Arkansas, Louisiana, Texas, and portions of Mississippi, Nebraska and New Mexico.

District No. 4 has its headquarters at Denver and includes the greater part of the states of Montana, Wyoming, Utah and Colorado and parts of North Dakota, South Dakota, Nebraska and New Mexico.

District No. 5 has its headquarters at San Francisco and includes, in addition to the Coast States, Idaho, Nevada and Arizona.

Federal Trade Commission Reports on Cost of Mining Coal

The sixth report of the Federal Trade Commission's series on the cost of producing coal in the United States, covering the States of Maryland, West Virginia and Virginia, which produce about 18 per cent of the total annual production of bituminous coal in the United States, presents information for the period from August, 1917, to December, 1918, based on monthly cost reports filed by the operators on forms prescribed by the commission and covers about 68 per cent of the output of Maryland during 1918, 89 per cent of the output of West Virginia and 77 per cent of that of Virginia. Information is also presented for certain districts in Maryland and West Virginia for 1916, 1917 and 1918, based partly on the information obtained by the commission's agents directly from the operators' books and partly on cost sheets submitted by the operators. This latter information covers from 14 to 53 per cent of the total output for the respective districts concerned.

The report shows that wide differences existed in 1918 between the conditions met by the operators in the fifteen mining districts of Maryland, West Virginia and Virginia for which statistics are given, and is of particular interest at the present time for comparison with the series of monthly bulletins on current 1920 costs, which are being issued by the commission. The basic 1918 figures are shown in the report in detail, and the various elements comprising the costs of operations such as labor, supplies, general expenses, as well as sales realization, in each district in 1918 are distributed through a wide range.

In 1918 for the production of over 90,000,000 tons mined in these three states by the 541 operators covered by the report, the average annual total f.o.b. mine costs as revised by the commission ranged, by districts, from $1.63 to $3.09, and the average sales realization ranged from $2.45 to $2.88 per ton of 2,000 pounds. In Maryland (which is a single district and includes also the Upper Potomac, Cumberland and Piedmont District in West Virginia) these average costs and sales realization in 1918 were $2.37 and $2.82 respectively, resulting in a margin of 45c. per ton. In West Virginia the average costs in 1918, by districts, ranged from $1.63 to $3.09 and the sales realizations from $2.45 to $2.88. If the Putnam County District be omitted, which had the high average cost of $3.09 and an average sales realization of only $2.76 per ton, the range of average costs for the remaining districts of West Virginia was from $1.63 to $2.35 per ton, and the range of margins was from 39c. to 92c. per ton. In the two districts of Virginia for which figures are given, the average costs in 1918 ranged from $1.93 to $2.48, the sales realizations from $2.58 to $2.81, and the margins from 33c. to 65c. per ton. The "margins," as elsewhere explained, are not the same as "profit."

The labor costs of the 71 operators in Maryland and in these three districts of West Virginia in 1918 were from 88 to 118 per cent higher, and the total f.o.b. mine costs in 1918 were from 92 to 109 per cent higher, than those in 1916. The sales realizations in 1918 were from 97 to 123 per cent higher than those in 1916. Of the amount paid for coal by the purchaser, based on each dollar of sales realizations during 1916-18, the item of most general interest is the proportion that labor received. That part of the amount paid by the purchaser which went to labor varied considerably from district to district, for these 71 operators in most districts, from period to period. It was highest (64 cents out of each dollar) in the Upper Potomac, Cumberland and Piedmont Districts of Maryland and West Virginia during the period June-December, 1918, and lowest (26 cents out of each dollar) in the Pocahontas District of West Virginia during the period April-May, 1917.

The detailed information contained in this report supplements that in the monthly bulletins which the commission is issuing at the present time, where necessarily averages only can be used in comparisons. The report further furnishes a safeguard against making too wide generalizations from the averages shown in the monthly bulletins.

Welded Boiler Explodes

At 11 a.m. on July 16, a small boiler of the firebox type exploded in a sawmill near McMinnville, Tenn., killing the fireman and a laborer, the former instantly, and badly scalding the owner and two others. The explosion was especially violent, completely demolishing the engine and mill equipment, and occurred without warning.

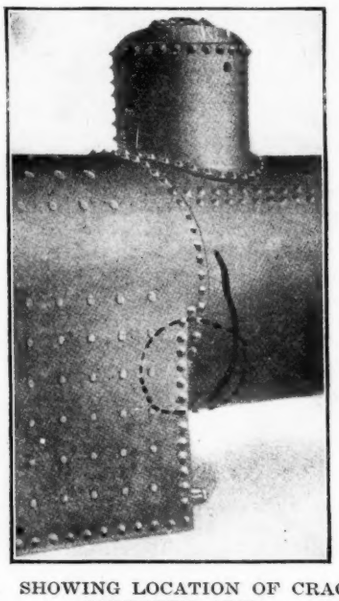


FIG. 1. SHOWING LOCATION OF CRACK AND CORRODED AREA

A few minutes before the explosion the owner noticed about one inch of water in the glass. The safety valve was popping off, and the gage showed 125 lb. The owner instructed the fireman, a green hand, to turn off the injector, and when the glass stood half full, he turned off the injector himself. Two or three minutes afterward the explosion occurred.

Fig. 1 shows the type of boiler, the heavy irregular line indicating an old internal crack in the shell almost two feet long. Within the area inclosed by the dotted line the plates and staybolts showed evidence of having been badly corroded. Only four inches of this long crack was visible from the outside, and this portion was welded

failure could not have been at the crack, actually stating that the failure of the sheet at this point would have relieved the pressure and therefore have rendered an explosion impossible. Such statements point to the necessity of rigid state inspection laws, and of operation of boilers only by competent men. There are undoubtedly hundreds

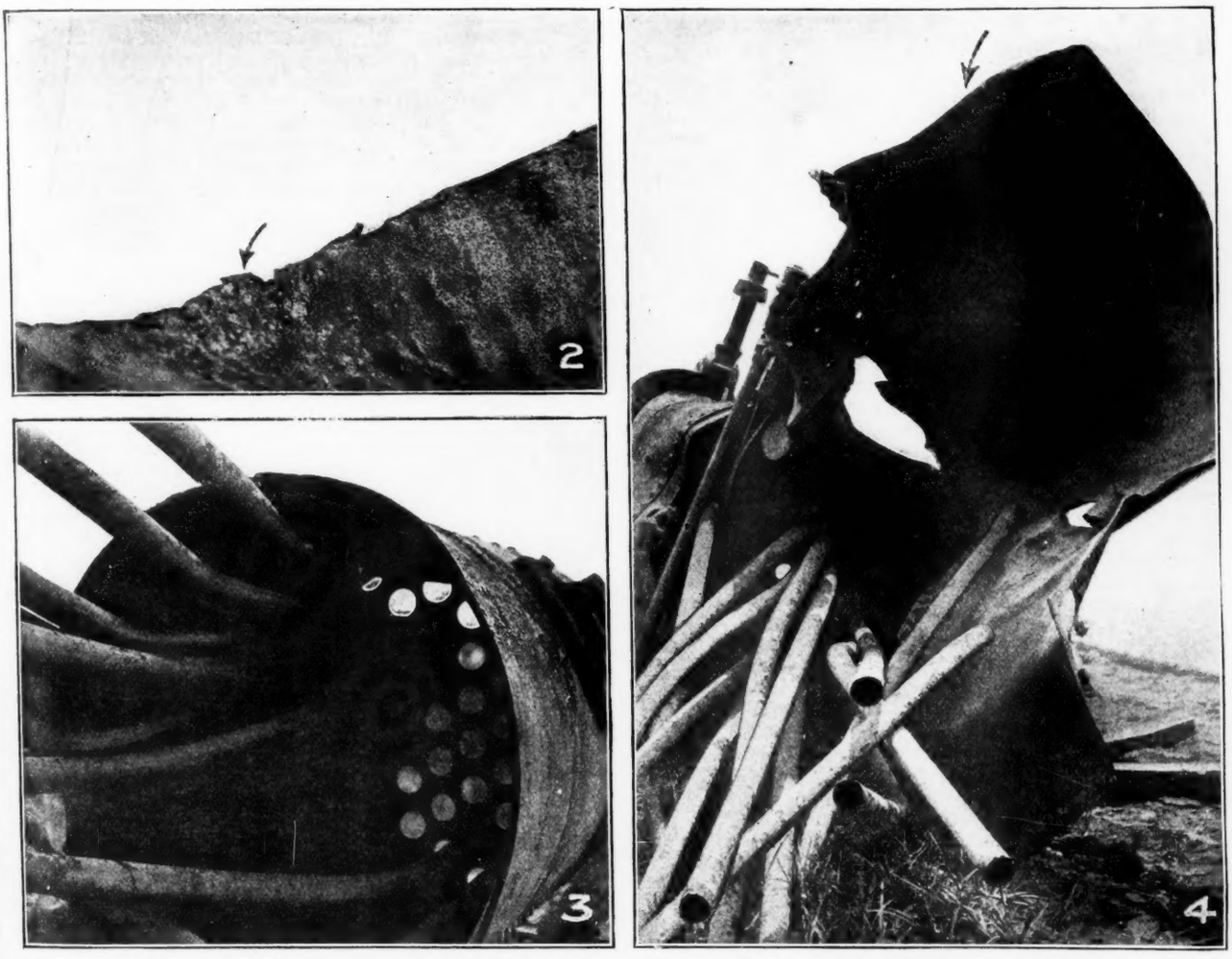


FIG. 2. THE WELD IN WHICH THE METAL WAS ONLY SPOTTED. FIG. 3. REMAINS OF FRONT END. FIG. 4. FIRE-BOX END, ARROW INDICATES LINE OF INITIAL RUPTURE

electrically about a year ago to prevent leakage. In welding, metal had simply been "spotted" over the crack, adding nothing to the strength of the sheet. The average thickness of the sheet over the entire length of the crack was something less than one-sixteenth inch. The condition of the sheet at this point may be seen in Fig. 2. The remainder of the metal in the boiler was in good condition, and the crown sheet showed no evidence of low water. The fusible plug was intact, although filled with shot lead.

The initial rupture apparently occurred at the point where the repair had been made by welding. The shell was torn entirely in two, and the two halves hurled one hundred feet away in opposite directions. The fracture followed the girth seam nearest the crack, but the violence of the explosion caused the shell to tear in several other places, and as part of the metal, including the steam dome, could not be found, it was impossible to trace exactly the entire course of the fracture.

This occurrence demonstrates the extreme hazard involved in operating even the smaller-sized boilers without experienced help and expert inspection, and of attempting by the welding process a repair of the kind described. The owner of the plant was inclined to the belief that the initial

of boilers in daily use in as hazardous condition as this one was, the lives of the workmen and the safety of the equipment hanging by a very slender thread.

Power Index Ready

The index for *Power*, Vol. 51, from January to June, 1920, inclusive, is now ready for distribution. Following the usual practice, this index will not be sent to every subscriber, but will be mailed to any subscriber on request, free of charge.

A corporation for the development of a power plant on Rock Creek, Missoula, Mont., is being formed. The incorporators are Judge F. C. Webster and John and Vincent Shaughnessy, all of Missoula. The new company will be incorporated for $500,000, and a majority of this amount is to be spent in the erection of a hydro-electric power plent at the mouth of Rock Creek, east of Clinton. According to Judge Webster, it is the intention of the new company to erect a plant that will generate about 20,000 hp., the greater part of which will be used by the De Smet irrigation district for pumping purposes.

The Electric Propelling Machinery of Future U. S. Capital Ships

The present naval program of the United States consists of two new classes of battleships and battle cruisers, which will compare with the ships of the type of the "Tennessee" as follows:

TABLE 1. COMPARISON OF NEW AND OLD BATTLESHIPS AND CRUISERS

	Tennessee	New Battleships	New Battle Cruisers
Length, over all, feet	624	684	874
Beam, feet	97	105	90
Draft, feet	31	33	31
Displacement, tons	33,000	43,200	43,500
Deed, knots	21	23	35
Mpain battery	Twelve 14-in. guns	Twelve 16-in. guns	Eight 16-in. guns
Shaft horsepower	30,000	60,000	180,000

The new battleships are to be electrically driven, and the main propelling equipment of four of them—the "Indiana," "Montana," "South Dakota" and "North Carolina"—will consist of two Westinghouse 28,000-kva. turbine generators and four 15,000-hp. Westinghouse propeller motors. The turbines are to be of the complete expansion, impulse-reaction type and will develop their full rated load at 265 lb. steam pressure, 50 deg. superheat, and 28½ in. vacuum. Electric power will be generated in the form of three-phase 60-cycle, 5,000-volt alternating current.

The statistics of the new battle cruisers given in the table indicate that these vessels are to be very unusual in many respects, but their most remarkable feature is the enormous power of their turbines—180,000 hp., or 160,000 kva. These figures do not, however, give an adequate conception of the magnitude of this power. Not only is it greater than that of any ship ever designed—for the power of the British cruiser "Hood" is 134,000 hp. and that of the "Leviathan" 90,000 hp.—but it is greater than that used by most cities of over half a million inhabitants. For example, the combined capacity of all of the central-station and electric-railway power houses of Pittsburgh is less than 150,000 hp.; of Baltimore, less than 160,000 hp.; and of Philadelphia, about 200,000 hp. There are, in fact, but two or three steam-power plants in the world that have greater capacity than the engine rooms of these battle cruisers will have, so that, from the standpoint of power engineering alone, the construction of these vessels will constitute an achievement of the highest order.

Two of these vessels, the "Ranger" and the "Constellation," will have the following equipment: Four Westinghouse main turbines to develop 49,750 brake hp. each, with steam at 265 lb., 50 deg. superheat, and 28½ in. vacuum; four 40,000-kva. Westinghouse generators, directly connected to these turbines and generating three-phase 51.3-cycle 5,400-volt alternating current; eight wound-rotor Westinghouse motors (two to each propeller), which are to be rated at 22,500 hp. each and will be the largest in the world.

Recent German Production of Coal and Products

The Bureau of Foreign and Domestic Commerce, Department of Commerce, issues the following table showing the production of coal, coke and briquets in Germany during the first quarter of 1920, compared with the production in the same periods in 1919 and 1913.

Products	January-March, 1920* Tons	January-March, 1919† Tons	January-March, 1913‡ Tons
Anthracite	30,699,793	29,113,702	47,558,449
Soft coal	25,009,552	21,054,443	20,917,977
Coke	5,712,810	5,395,251	7,991,860
Anthracite briquets	1,057,268	953,095	1,436,225
Soft coal briquets	5,256,611	4,304,248	5,048,260

* Exclusive of Saar district, the Pfalz, and Alsace-Lorraine. † Exclusive of Alsace-Lorraine. ‡ Inclusive of Alsace-Lorraine.

In the first quarter of 1919 the production of anthracite in the Saar district and the Pfalz was 2,407,475 tons, and of coke 208,118 tons. In the same period of 1913 the production of anthracite in Alsace-Lorraine, the Saar district, and the Pfalz was 4,397,744 tons, and of coke 431,435 tons.

The Federated American Engineering Societies

The object of the Federated American Engineering Societies is to further the public welfare wherever technical knowledge and engineering experience are involved and to consider and act upon matters of common concern to the engineering and allied technical professions.

The organization is not a new one, but will be a successor to the existing Engineering Council, whose work will be amplified and carried out on a much more extended plan as to scope and membership.

The basis of representation, where a state organization exists and where there are also strong local organizations and affiliations as provided for in the constitution, places the State Council or organization representative of the engineers and allied technologists in the state on an equal plane with all the engineers and technologists in the state. The by-laws provide that "Any society or organization of the engineering or allied technical professions whose chief object is the advancement of the knowledge and practice of engineering or the application of allied sciences and which is not organized for commercial purposes, is eligible for membership."

The Federated American Engineering Societies will function through the American Engineering Council, which will meet either annually, or bi-annually, as it will determine. This American Engineering Council will consist of representatives from the member societies on the basis of one representative for from 100 to 1,000 members and an additional representative for each additional 1,000 members or major fraction thereof. From this body of representatives will be formed an executive board of thirty, consisting of six officers and twenty-four other members selected in part from the national societies and the remainder from the local, state or regional organizations or affiliations. The plan reported by the committee on constitution and by-laws provided that the representation on the executive board should be based on the ratio of the total number of members in the national societies to the total number of members in the local, state and regional organizations or affiliations. The organizing conference, however, changed this to the ratio of the number of representatives from the national societies to the number of representatives from the local, state and regional organizations or affiliations, on the American Engineering Council. This executive board will meet monthly or as often as may be found to be necessary to properly transact the business of the American Engineering Council. There will be an executive officer, who will also be the secretary of these bodies and who will be entrusted with carrying out their instructions.

The Joint Conference Committee is unqualifiedly of the opinion that an opportunity has been created for bringing about a solidarity of the engineering and allied technical professions that has never heretofore been available, and that the success of the movement will depend on the wholehearted support of each American engineer and of each technologist, who, if determined that this movement shall succeed, will obviously not bother with the details or the form of organization, in his effort to secure the end designed.

Development of the Bridge River power site near Lillooet, Vancouver, B. C., calling for an eventual expenditure of $30,000,000 is in its initial stages, surveying and preliminary work now being carried on. Plans call for a tunnel a mile and a half long under Mission Mountain, discharging into Seaton Lake, six miles from Lillooet. The fall will be 1,400 ft., and it is estimated that 400,000 hp. can be developed.

Collapse of a retaining wall in the boiler room of Nokomis flour and feed mill in Minneapolis, July 20, caused the death of one employee of the mill and serious injury of another. The wall gave way under a pressure of 200 tons of coal against it. City firemen and employees of the mill worked two hours frantically digging to release the unfortunate men.

The Coal Reconsignment Evil

ALL responsible operators throughout the country have deplored the development of a situation that has made it possible for the speculator to step between the coal producer and the consumer and to load on prices way beyond those prevailing at the mines. The lamentable lack of open-top car supply, existing since the beginning of spring, preventing the operators from shipping the coal required by the Nation, is the factor that has paved the way for the play of speculative prices wherever they have appeared.

One factor that has worked to the advantage of coal manipulators in this emergency has been the practice of the reconsignment of carloads of coal, for which the railroads are responsible. Under this practice carloads of coal obtained by speculators at a low price have been started out to an original consignee, later on the speculator—in the meantime having obtained a better price elsewhere—causing the shipment to be reconsigned to another destination. In many instances carloads of coal in this way have been reconsigned two and three times, with a higher price tacked on at each point.

The bituminous-coal producers have time and again protested against this practice of reconsigning cars. The option of resorting to its use has been entirely with the railroads. On July 12, at a conference of bituminous operators in Washington, a protest against reconsignment of coal cars was voiced, the Interstate Commission being asked to limit it to the "greatest possible extent, in order to eliminate existing abuses." On the following day Chairman E. E. Clark, of the Interstate Commerce Commission, in a letter to Daniel Willard, head of the Association of Railway Executives, urged that the railroads bring down the reconsignment of cars "to the unavoidable minimum."

Under the reconsignment of cars coal has been held at different points along railroad lines, as well as at terminals, for days at a time during the coal-shortage emergency, depriving consumers of a supply that has been badly needed. Industrial concerns, public utilities and other consumers have had to wait for coal while these reconsigned shipments were standing in cars upon the tracks.

Although the speculators have been able to obtain only a relatively small proportion of the coal output, the effect of their activity has been to further disrupt a situation that for months has affected the nation's coal output. With an unprecedented demand everywhere, many bidders have been willing to pay whatever price was necessary in the open market so as to get coal.

Urges Enforcement of Orders Prohibiting Reassignment of Coal Cars

Suggestions for relieving the acute coal crisis in New York State and New York City, and in New England have been offered to the Interstate Commerce Commission and the United States Shipping Board in letters addressed to those bodies by Senator William M. Calder, of New York, chairman of the special Senate Committee on Reconstruction and Production. The suggestions arose out of information received by the committee in the course of its recent hearings.

In his letter to the Interstate Commerce Commission, Senator Calder says in effect that allegations have been made that priority orders issued by the commission in the past have been ineffective. It has been charged, the letter says, that cars diverted to the coal trade by recent priority orders are held in transit for speculative purposes, making most urgent the enforcement of orders by the commission prohibiting more than one reassignment of coal cars. Much confusion exists in the public mind as to the purport of the order some time since issued by the commission, requiring shippers to secure permits for the export of coal according to information given to the Senate committee. Senator Calder calls the attention of the Interstate Commerce Commission to representations that he has received as to the necessity for curtailing shipments of coal abroad in order to conserve the supply of cars for domestic needs. It has been pointed out, he says, that such curtailment "would reduce the price of coal in this country, would relieve the domestic shortage of coal and would release cars for general industry." As typical of many communications received by the committee, he encloses a copy of a telegram urging restriction on exports received by the Senate committee from Louis J. Hill, chairman of the Board, Great Northern Railroad, which reads in part:

> Regarding exportation, we feel conditions require this country's needs be taken care of before coal is shipped to foreign countries. If it were possible to mine a surplus of coal, it would be desirable to find an export market, but with the serious shortage in practically every state, the needs of this country should be adequately taken care of before exporting coal. We feel exorbitant prices being paid by agents of foreign countries for export coal have had an unusual effect on price and distribution in this country.

In conclusion Senator Calder invited members of the Interstate Commerce Commission to appear before his committee with a view to clearing up issues at present in doubt.

To the Shipping Board Senator Calder points out that some coastwise shipping is reported to be lying idle awaiting charter, and that this situation is accentuated because the present cost of transporting coal to New England by water is "some two dollars greater than the cost of all-rail coal transportation." As a remedy he suggests a reduction, during the present emergency, in water coal rates to New England, in place of the increase in rates which the committee has been advised is impending.

Penalty for Holding Cars

Tangible results in the campaign to eliminate the speculator and bring down excessive prices where they exist in the open market, are already in evidence. One of the immediate developments in this move is the order just issued by the Interstate Commerce Commission restricting the reconsignment of open-top coal cars.

The commission's penalty of $10 a day on loaded cars held beyond 48 hours at any destination is expected to stimulate rapid unloading of cars and in that way release much-needed equipment now in the hands of speculators.

While backing the Interstate Commerce Commission's reconsignment order, the bituminous-coal operators represented in the National Coal Association, embracing two-thirds of yearly output of soft coal, feel that the prohibition against the practice should go further, so as to make it apply to shipments to tidewater, either for export trade or transshipment by vesssel to American seaboard ports. Means to bring this about are being considered by the committee of soft-coal operators engaged in export trade appointed by Col. D. B. Wentz, president of the National Coal Association, last week.

Coal Exportation for 1920

Figures gathered by the Geological Survey indicate that the total amount of coal dumped at tidewater for the first six months of 1920 has approximated 23,000,000 tons. Of this amount, approximately 5,000,000 tons was destined for coastwise shipment to New England. Of the remainder, approximately 10,000,000 tons was exported across the Atlantic. The remainder, approximately 8,000,000 tons, was used for bunker coal. In view of the fact that trans-atlantic shipping was considerably higher in 1918 and probably in 1919, than it is at present, this figure of 8,000,000 tons for bunker coal cannot be materially greater than it has been in the past.

The Geological Survey, under date of July 26, 1920, further states that for the first six months of this year we have exported to Canada a total of 4,595,000 tons. There was a total export for the same period of 1919 of 5,700,000 tons, in 1918 of 7,740,000 tons, and in 1917 of 6,400,000 tons. It is interesting to note that these figures are compiled from the Canadian import figures, and they are undoubtedly very nearly correct.

New Publications

EXPORTER'S GAZETTEER OF FOREIGN MARKETS, By Lloyd R. Morris, Research Editor of the *American Exports*, New York City. Cloth, 6 x 9 in.; 808 pages. Price $10.

The object of this book is to furnish a reference guide to imports and exports, industries, shipping, banking, products, climatic and other local conditions of foreign markets. A handy and valuable feature of the arrangement of the work is that all the commercial and industrial statistics and weights and measures have been converted into the American systems. The countries of the world have been grouped in alphabetical order by continents and other major geographical divisions so that adjoining markets are found together. Detailed information is given under each country upon area, population, commerce, production, industries, railroads, telegraphs, telephones, money, weights, measures, commercial language, local advertising media, principal shipping routes, customs tariffs, consular regulations and consular representatives, cable rates, mail time, postal rates and regulations, respecting parcel post, money orders and reply coupons. Tables showing the value of foreign trade over a number of years are given for each country. The value of imports and exports by commodities and countries and value of its imports from and exports to the United States for ten or more years are also given. In the book are included a number of charts, a map of the world, a map of New Europe and line maps of each of the markets.

Personals

Earl M. Anderson, of Carlinville, Ill., has been made assistant electrical engineer of the power house of the Standard Oil Co., at Schoper, Ill.

E. A. Pahenney, of Golden, Col., has been elected chairman of the Rocky Mountain Geographic Section of the National Electric Light Association.

Edward W. Harry has resigned as electrical engineer for the National Tube Co., to become chief electrical engineer with the Pittsburgh Steel Co., at Monessen, Pa.

Lloyd Henley, electrical engineer with the California Railroad Commission, has left the commission to take up the work of rate research engineer with San Joaquin Light and Power Corporation.

T. D. Ramm has resigned from the St. Paul Gas Light Co., where he was general superintendent of the electrical division, to become connected with the Pennsylvania-Ohio Electric Co., Youngstown, Ohio.

Roy M. Green, professor of highway engineering at the Agricultural and Mechanical College of Texas, has resigned that position to become president and manager of the Western Laboratories at Lincoln, Nebraska.

E. E. Lenson has assumed the duties of advertising manager of the B. F. Sturtevant Co., Boston, Mass. Mr. Leason has been connected with this company for ten years and is well qualified to fill his new position.

W. J. Kaup has resigned his position as chief engineer with the Crucible Steel Co. of America, and will devote his time to consulting work entirely. Mr. Kaup was formerly with the Westinghouse Electric and Manufacturing Co.

Prof. M. E. Cooley, dean of the engineering Department of the University of Michigan, was elected president of the National Society for the Promotion of Engineering Education at a recent convention held by the society at Ann Arbor, Mich.

William Tietze has severed his connection with the Citizens Heat, Light and Power Co., of Canby, Minn., and has assumed the position of chief engineer of the B. F. Nelson Manufacturing Co., paper manufacturers, of Minneapolis, Minn.

O. M. Booher, who for the last twelve years has been manager of sales for the Indiana Railways and Light Co., Kokomo, Ind., has resigned to become general manager of the Kokomo Brick Co. Mr. Booher was very active in committee work of the Indiana Electric Light Association.

C. G. Bigelow, for the last three years advertising manager of the B. F. Sturtevant Co., Hyde Park, Boston, and previous to that for five years manager of the Chicago office of the same company, has resigned to become advertising manager of the Graton & Knight Manufacturing Co., of Worcester, Mass. Mr. Bigelow has had a wide experience in technical work which will qualify him for this new field.

T. H. Arnold has resigned as chief electrician of the Mining Department of the Arizona Copper Co., Ltd., with headquarters at Morenci, Ariz., to accept the position of electrical engineer for the Southwestern Portland Cement Co., of El Paso, Tex., and Victorville, Cal. Mr. Arnold graduated in electrical engineering at the Pennsylvania State College in the class of 1905 and has had a wide experience in the application of electric power to mining and industrial enterprises.

M. O. Leighton and **Major C. T. Chenery**, members of the American Society of Civil Engineers, and **A. C. Oliphant**, associate members of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, have formed a copartnership under the name of M. O. Leighton & Co., with offices at 700 Tenth St., Washington, D. C., for the purpose of engaging in general engineering practice and industrial representation before the Federal departments. Mr. Leighton and Major Chenery will continue for the time being as chairman and secretary respectively of the National Public Works Department Association, while Mr. Leighton and Mr. Oliphant will continue service in the Washington Office of Engineering Council pending the displacement of that body by the Federated American Engineering Societies.

Col. Edward B. Ellicott, Chemical Warfare Service, U. S. A., has received honorable, discharge after two and one-half years' service and has become associated with A. M. Castle & Co., iron and steel merchants, Chicago, as chief engineer. In addition to being in charge of the erection of the new plant of A. M. Castle & Co., of Washington, at Seattle, and also the additional buildings to be erected in Chicago, he will be engaged in the operating and manufacturing activities of the company and its associated interests. Previous to entering the service Colonel Ellicott was city electrician of Chicago for eight years, and chief electrical engineer of the sanitary district of Chicago for eleven years, developing the hydro-electric power plant. During a leave of absence from Chicago, granted at the request of the Exposition officials, he became the chief mechanical and electrical engineer of the Louisana Purchase Exposition at St. Louis.

Society Affairs

The American Association of Engineers has passed the 20,000 membership mark. The association for some time has had the largest organization of engineers in the world.

The Montana Assembly of the American Association of Engineers elected William J. McMahon of Butte as president. Mr. McMahon is chief mining engineer for several mining corporations owned by the Anaconda Company. C. A. Bowden, chief draftsman of the Anaconda Copper Mining Company of Butte, was elected secretary. He is also secretary of the Butte Chapter.

At the Pan-Pacific Scientific Congress to be held in Honolulu, Hawaii, from Aug. 2 to Aug. 20, the Chicago Chapter of the American Association of Engineers will be represented by Miss Florence King, a consulting engineer and patent attorney of Chicago, who is the only certified woman member of the American Association of Engineers. Miss King is sailing at once for Honolulu and will attend all the sessions of the congress.

The Executive Committee of The American Association of Engineers has selected to constitute the National Railroad Council of A. A. E., sixteen railroad professional engineers. They are: George W. Hand, C. & N. W., Chicago, chairman; W. W. K. Sparrow, C., M. & St. P., Chicago; W. Evans, C. & A., Chicago; K. B. Lattimer, C., B. & Q., Chicago; W. C. Bolin, B. & O., Chicago; F. C. Shepherd, B. & M., Boston; S. H. Brenaman, Penn., Pittsburgh; A. H. Utter, C., B. & Q. W., Lincoln; Harold Knight, Erie, Youngstown; C. I. Long, N. Y. C.-W., Cleveland; C. C. Berritt, Southern, Washington, D. C.; Lef Winship, Mo. Pac., St. Louis; J. E. Debb, M. C., Detroit; J. T. W. Jennings, E. J. & E., Joliet; H. I. Benjamin, S. Pac., San Francisco, and F. C. Huffman, C. & N. W., Chicago.

The American Association of Engineers—An Industrial Department has formally been authorized by the Board of Directors of the association. Steps are under way to organize this department and take up consideration of the problems of mechanical, electrical and chemical engineers in industrial work. A. M. Cornell, chief engineer of the Pettibone & Mulliken Co., of Chicago, will supervise the activities of the department until such time as the duties warrant the employment of a full-time paid secretary.

The Committee on the Reclassification and Compensation of Engineers has submitted a report to Engineering Council on a standard classification of grading for engineering service, with a tentative schedule of standard rates of compensation in each of the proposed grades. The adopted classification and the corresponding schedule of compensation tentatively suggested are as follows: Junior Aid, $1,080 to $1,560; Aid, $1,680 to $2,400; Senior Aid, $2,500 to $3,240; Junior Assistant Engineer, $1,620 to $2,580; Assistant Engineer, $2,700 to $4,140; Senior Assistant Engineer, $4,320 to $5,760; Engineer, $5,940 and upward; Chief Engineer, $8,100 and upward.

The Association of Iron and Steel Electrical Engineers will hold its fourteenth annual convention in the Hotel Pennsylvania, New York City, Sept. 20 to 24. The following tentative program of papers will be presented during the convention: "A Condensed History of Ore and Coal Loading and Unloading Machinery," W. K. Monroe; "The Reversing Electric Mill Considered from the Standpoint of Tonnage," K. A. Pauly; "Power Transmission for Industrial Plants." D. M. Petty; "Centralized Turbine Generating Stations for Steel Mills," T. E. Keating; "Some Considerations in the Determination of Auxiliary Drives," Gordon Fox; "Report of Electrical Development Committee for 1920," E. S. Jefferies, chairman; "Relation of Standardization in Electrical Equipment to Safety," Walter Greenwood;" "Report of Electric Furnace Committee for 1920," E. T. Moore, chairman; "Standardization Committee Report," W. T. Snyder, chairman; Practical Education of Steel Mill Electricians," Educational Committee; 'Underground Transmission," A. L. Freret; "Current Limit Reactance," R. H. Keil.

Miscellaneous News

The National Exposition of Chemical Industries, which will be held at the Grand Central Palace, New York, Sept. 20-25, will have for the first time a **Fuel Economy** Section.

It Is Planned to Begin Work at an early date on a power development on the Colorado River, north of Flagstaff, which will supply, among other services, four hotels to be built and 300,000 acres of irrigation effected by the power development.

The Federal Power Commission at a recent meeting planned to form a National Organization composed of the following subdivisions: Engineering, accounting, statistical, regulating, licensing, legal and operation. The country has been divided into five districts as follows: No. 1, Washington; No. 2, St. Paul; No. 3, St. Louis; No. 4, Denver; No. 5, San Francisco. Branch offices will be maintained in each city.

Business Items

The Chicago Pneumatic Tool Co., of New York and Chicago, announces that its publicity department has moved to the Chicago Pneumatic Building, 6 East 44th St., New York City.

The Mohawk-Edison Co. and the **Adirondack Electric Power Corp.** have been consolidated into the Adirondack Power and Light Corp., in conformity with orders of the Public Service Commission of New York.

New Construction

PROPOSED WORK

Mass., Worcester—H. W. Trulson, 35 Berksmans St., will soon award the contract for a 2 story, 90 x 115 ft. garage including a steam heating system on Pleasant St. About $150,000. E. T. Chapin, 340 Main St., Archt.

N. Y., Buffalo—The Bureau of Water Supply is in the market for thirteen, 3 phase, 2,300 volt switchboard panels.

N. Y., Buffalo—The Bureau of Water Supply is in the market for 1 multistage centrifugal type pump to have a 250 gal. per min. capacity with a 10 ft. suction head capable of discharging against head of 700 feet.

N. Y., Marcy—The State Hospital Comn., Capitol, Albany, will receive bids until August 25 for a pumping station, filtration plant, etc., for the Utica State Hospital here. E. S. Elwood, Secy. Noted July 13.

N. Y., New York — The United Zinc Smelting Corp., 233 Bway., is in the market for 2 boilers, 250 kw. direct connected unit for generating two 100 hp. motors for fans, two 20 hp. kiln motors, three 20 hp. elevator motors, two 5 hp. gas producer motors, etc. J. W. Murry, Engr.

N. Y., Syracuse—The Common Council plans to build a pumping station and storm sewer. About $100,000. H. C. Allen, City Hall, Engr.

N. J., Camden—The Victor Talking Machine Co., Front and Cooper Sts., will soon award contract for a 1 story, 60 x 69 ft. boiler house. Ballinger & Perrot, 17th and Arch Sts., Philadelphia, Pa., Engrs.

N. J., West Orange—The Thomas A. Edison Co., Lakeside Ave., will receive bids about August 25 for an addition to its plant and about September 1 for equipment for same. About $80,000. Lockwood Green & Co., 101 Park Ave., New York City, Engrs.

Pa., Bakerstown — The Pittsburgh Cut Flower Co. had plans prepared for a 1 story, 57 x 72 ft. boiler house. About $75,000. Charles Bickel, May Bldg.,, Pittsburgh, Archt.

Pa., McKeesport—The McKeesport Hospital plans to build a 3 story power building, dormitory, nurses home, etc. About $250,000. S. F. Heckert, Bessemer Bldg., Pittsburgh, Archt.

Pa., Philadelphia—Berger Mfg. Co., 16th and Washington Sts., is in the market for a power saw table.

Pa., Philadelphia—The Germantown Y. M. C. A., 5849 Germantown St., will have plans prepared for a Y. M. C. A. building including a steam heating system on Haines and Germantown Sts. About $400,000. Martin & Kirkpatrick, 130 South 15th St., Archts.

N. C., Asheville—The Asheville Power & Light Co. plans to remodel and enlarge its power plant. About $100,000. John D. Caldwell, Supt.

Ga., Savannah—The Bd. Educ. plans to build a 2 story, 152 x 158 ft. school, $500,000 and a 3 story, 148 x 224 ft. school, $1,000,000, here. A low pressure steam heating system with electrically operated ventilating system will be installed in each. William B. Ittner, Bd., Educ. Bldg., St. Louis, Mo., Archt.

La., Lauderdale—S. J. Matz, Asst. Mgr. of the Salsburg Refining Co., Ltd., plans to install 4 boilers.

O., Cleveland—The Amer. Turpentine Co., 136 Engineers Bldg., plans to build a 1 story, 24 x 40 ft. boiler house and a 3 story, 100 x 180 ft. factory along the Beltline Ry., here. Two 300 hp. boilers will be installed in same. About $200,000. H. D. Tremmel, Secy.

O., Cleveland — The Gongwer Syndicate, c/o W. S. Longee, Archt., 500 Marshall Bldg., plans to build a 10 story, 50 x 100 ft. office building including a steam heating system on East 3rd St. and Lakeside Ave. About $500,000.

O., Cleveland—Nathan Kritzer, 10514 Massie Avenue, is in the market for one 2 hp., a.c., 60 cycle, 220 volt electric motor.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ., Lee Rd., is having plans prepared for a 3 story school, including a steam heating system on Taylor Rd. About $500,000. E. K. Bryan, Clk. F. C. Warner, Hippodrome Annex Bldg., Archt.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ., Lee Rd., plans to build a 50 x 67 ft. heating plant for Public School on Lee Rd. Three 200 hp. boilers, overhead conveyer system, stokers, 3 turntables, ashpit and blower system will be installed in same. About $100,000. E. K. Bryan, Clk. L. A. Quayle, 1455 West 98th St., Cleveland, Engr.

O., Linden (Columbus P. O.)—The Bd. Educ. will receive bids until August 20 for the construction of a grade school including a steam heating system. E. B. McFaddin, Clk. D. Ruhil & Son, New Trust Natl. Bank Bldg., Archt.

O., Oxford—The city is in the market for new electrically driven centrifugal pumps in connection with the proposed hydraulic development here. About $100,000. L. A. Boulay Co., 1250 Nicholas Bldg., Toledo, Engr.

O., Springfield—Clark County nad plans prepared for a 3 story, court house including a steam heating system. About $245,000. W. K. Shilling, Fox Hollow Farm, Archt. and Engr.

Ind., Evansville—J. E. Pridmore, Archt., 38 South Dearborn St., Chicago, will soon award the contract for a 6 story, 144 x 148 ft. hotel and theatre building including a steam heating system for the Standard Evansville Realty Co.

Mich., Detroit — The General Forgings Corp., c/o J. D. Edwards, 54 Lafayette Blvd., plans to build a 3-story, 65 x 210 ft. drop forging shop. Plans include a steam heating plant.

Mich., Detroit — Smith, Hinchman & Grylls, Archts. and Engrs., 710 Washington Arcade, will soon award the contract for a 2 story, 60 x 117 ft. factory including a steam heating system and motors for power on Hart Ave., for the Zenith Carburettor Co. About $70,000.

Ill., Chicago—The West Disinfectant Co., 2637 Cottage Grove Ave., is in the market for miscellaneous equipment including an electric winch with a 12 hp. motor.

Ill., Granite City—The Bd. Educ. is having plans prepared for a 3 story school including a low pressure steam heating system. About $280,000. William B. Ittner, Bd. Educ. Bldg., St. Louis, Mo., Archt.

Wis., Campbellsport—The White House Milk Products Co., West Bend, is having plans prepared for a 1 story, 50 x 100 ft. condensed milk plant. Two 150 hp. tubular boilers will be installed in same. M. Tullgren & Sons, 425 East Water St., Milwaukee, Archts.

Wis., Cedarburg—Fred Schuette, City Clk., will receive bids until August 24 for one air compressor, one 300 g.p.m. motor driven centrifugal pump, and one 60 hp., 2 phase, 60 cycle, 440 volt motor, a 20 x 26 ft. pumping station, etc. About $200,000. W. G. Kirchoffer, 3 Vroman Block, Madison, Engr.

Wis., Cudahy—The Worthington Pump & Machinery Co. will soon award the contract for a 3 story, 60 x 170 ft. pattern shop. Electric motors will be installed in same.

Wis., Milwaukee—The Park Bd., City Hall, received bids for the furnishing of new heating boilers for the Mitchell Park Conservatory, from the General Heating & Ventilating Co., 198 Milwaukee St., one at $5,700, $5,100 and $6,860.

Wis., Racine—The Bd. Educ., City Hall, is having preliminary plans prepared for a 3 story junior high school including a steam heating system. About $400,000. E. B. Funston Co., Robinson Block, Archt.

Ia., Des Moines—The State Bd. of Comrs., Capitol Bldg., plans to build a 3 and 4 story, 190 x 200 ft. power plant. About $200,000. Canfield Eng. Co., Flynn Bldg., Engr.

Kan., Arcadia—The city is in the market for pumps and equipment including an air lift, centrifugal pumps, etc. in connection with the proposed waterworks system. W. B. Rollins Eng. Co., Ry. Exch. Bldg, Kansas City, Mo. Engr.

Kan., Minneola—The City Clk. will soon award the contract for all labor and material necessary for the construction of a water works system including two 100 g.p.m. deep well pumps and motors, pump houses, etc. W. B. Rollins Eng. Co., Ry. Exch. Bldg., Kansas City, Mo., Consult. Engr.

N. D., Hankinson—G. W. Rennex, City Aud., will soon award the contract for two 500 gal. fire pumps, 2 deep well pumps, etc. About $50,000. Dakota Eng. & Constr. Co., Valley City, Engr.

S. D., Mitchell—Rapp & Rapp, Archts., 190 North State St., Chicago, will receive bids until August 15 for a 3 story, 150 x 180 ft. auditorium including a steam heating system, for the city. About $500,000.

Mo., Poplar Bluff—The city is in the market for 1 auxiliary pump and boiler accessories. W. T. Morris, c/o Bd. of Pub. Wks.

Mo., St. Louis—The city plans to build a power house addition to the Koch Hospital. An additional boiler and generator will be installed in same. About $23,000. L. R. Bowen, City Hall, Engr.

Ark., Cotter—The Dixie Power Co., Little Rock, plans to build a dam across the White River to generate electrical power. Henry A. Allen, Chicago, Ill., Engr.

Ark., Fort Smith—The St. Edwards Hospital Bd., North 15th and A Sts., is having plans prepared for a 4 story, 70 x 128 ft. hospital including a hot water heating system. About $250,000. Hedrick & Huff, Interstate Bldg., Kansas City, Mo., Engrs., A. Klingensmith, Rowland, Okla., Archt.

Col., Denver—The School Bd. will receive bids until Sept. 15 for a 2 story, 125 x 350 ft. junior high school. Electric motors will be installed in same. About $420,000. W. N. Bowman, Central Savings Bank Bldg., Archt.

Ariz., Bouse—R. M. Stene & Associates plan to build a dam across the William River for power and irrigation purposes.

Ariz., Phoenix—Carrick & Mangham have made an agreement with the Salt River Valley Water Users' Association to install pumps, build drainage irrigation ditches and steam plant to generate 5,000 kw. electrical energy. G. W. Sturtevant, Engr.

Ariz., Phoenix—The Landowners are having plans prepared for the installation of 350 second ft., electrically operated pumping plant, individual pumping units, etc., cost $800,000, ultimate cost, $4,000,000. Reed & Baker, 519 Fleming Block, Engrs.

Ariz., Phoenix—The Paradise Verde Irrigation Dist. plans to build a power plant along the Verde River here in order to utilize the waters of the River for power and irrigation purposes. Cost, from $16,000,000 to $20,000,000.

B. C., Trail—The Consolidated Mining & Smelting Co. of Canada plans to install three 200 hp., 550 volt motors direct connected to three 3 stage centrifugal pumps with a capacity of 550 gal. per min. and designed to pump against a head of 337 ft. rating 1,500 r.p.m. in the main pumping station on the banks of the Columbia River here; a relay station having 2 pumps similar to those in the main pumphouse; a 1,200 k.v.a. synchronous motor generator set, 2,200 volt motor and a 200 volt generator in the additions to its copper plant.

Ont., Acton—H. A. Cox, Chn. of the Water Bd., will soon award the contract for furnishing and installing two 250 Imp. gal. per min. pumps direct connected to 220 volt, 25 cycle, 3 phase, a.c., electric motors and motor driven centrifugal pumps, for the town. About $16,000. E. A. James Co., 36 Toronto St., Toronto, Engr.

Ont., East View—The Town Council voted $75,000 bonds to install new water-mains, pumping machinery, etc. Patterson & Bryne, 71½ Sparks St., Ottawa, Engrs.

Ont., Exeter—The Exeter Creamery Co. plans to build an addition to its plant and is in the market for machinery and equipment for same.

Ont., Fordwich—The ratepayers plan an election August 17 to vote on $10,000 bonds to provide for the installation of a hydro-electric lighting and power distribution system.

Ont., Hamilton—The Bd. Educ. plans to build a 2 story school including a vacuum steam heating system. About $125,000. Grayson Brow, Clyde Bldg., Archt.

Ont., Hamilton—The Steel. Works of Canada, Harvey Lane, will soon receive bids for a 1 and 2 story steel plant and foundry including a steam heating system. About $300,000.

Ont., Toronto—The city plans an election in January to vote on $8,000,000 bonds to build a waterworks system in the eastern section of the city to include intakes, pumphouse, filters, high and low pressure pumps, reservoirs capable of handling 100,000,000 gal. R. C. Harris, City Engr.

CONTRACTS AWARDED

Me., Brunswick — Bowdoin College has awarded the contract for remodeling the heating and lighting plant, to Blackstone & Smith, 185 Middle St., Portland, at $25,000.

Mass., Holyoke—The Holyoke Water Power Co. has awarded the contract for the installation of turbine wheels in the proposed plant $50,000 and in the proposed addition to plant, $70,000, to James Leffel & Co., Springfield, O.

Mass., Holyoke—The Holyoke Water Power Co. has awarded the contract for the installation of generators which will be used to supply additional electric current, to the General Electric Co., 387 Main St.

Mass., Springfield—The Wallace Realty Trust Co., 392 Main St., has awarded the contract for altering boiler house and garage, to E. J. Pinney, Inc., 374 Main St., at $26,500.

Conn., Bridgeport—H. N. McCathron, 72 Knowlton St., will build a 1 story, 60 x 220 ft. forge building including boilers, etc., on Cross St. About $20,000. Work will be done by day labor.

Pa., Essington—The Westinghouse Electric & Mfg. Co., has awarded the contract for a 1 story, 120 x 200 ft. foundry building including a steam heating system, to the Austin Co., Bulletin Bldg., Philadelphia.

O., Cleveland — The Anshi Beth Tephito Congregation, 10615 Grantwood Ave., has awarded the contract for a 2 story, 150 x 240 ft. synagogue including a steam heating system on East 105th St. and Hayden Ave. to the Edwards Eng. Co., Hippodrome Annex Bldg., at $500,000. Noted Jan. 20.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., has awarded the contract for the installation of a steam heating system in school building, including two boilers, etc., to John W. Danforth, 70 Ellicott St., Buffalo, N. Y.

O., Columbus—The Bd. Educ. has awarded the contract for installing a heating and ventilating system in the proposed 2 story, 100 x 190 ft school on Sullivant Ave., $35,383 and 2 story, 120 x 200 ft. school on Taylor Ave., $35,382, to Huffman & Wolfe, 669 North High St.

Mich., Caro—Cooper & Stiffler has awarded the contract for a 1 story, 75 x 140 ft. garage and salesroom including a steam heating system, etc., to the O. W. Jenkins & Co., 388 Dearborn St., Chicago, at $35,000.

Mich., Detroit — The Bd. of Water Comrs., 232 Jefferson Ave., has awarded contract for a 1 story, 90 x 120 ft. machine shop to Martin & Krausman Co., 747 Garland Ave., at $21,180. Motors will be installed in same.

Mich., Detroit—The Wood Hydraulic Hoist & Body Co., 1789 Hartwick Ave., has awarded the contract for a 2 story, 140 x 400 ft. factory including a steam heating system and electric power, to William Reynolds, 320 Lightner Bldg.

Ill., Chicago—The Chicago Junction Ry. Co., 38 South Deniston St., has awarded the contract for an addition to the boiler room and the installation of two 150 hp. high pressure boilers, compressor room, air compressor, etc., to E. W. Sproul Co., 2001 West 39th St., at $80,000.

Ill., Chicago—David Levi & Co., West 40th St. and Packers Ave., has awarded the contract for a 3 story, 115 x 170 ft. packing plant including a steam heating system on West 39th St. and Emerald Ave., to Jacob Rodatz, Rookery Bldg., at $350,000.

Ill., Kankakee—The W. Terman Produce Co. has awarded the contract for a 2 story, 48 x 15 ft. factory and warehouse including a steam heating system, on 15th St. and the New York Central tracks, to the Dehrens Constr. Co., 1732 North Western Ave., at $60,000.

Wis., Roberts—The Bd. Educ. has awarded the contract for installing a heating and plumbing system in the proposed 2 story, 62 x 69 ft. addition to high school, to the New Richmond Heating & Plumbing Co., New Richmond, at $17,400.

Ia., Davenport — C. A. Koester, c/o Davenport Roofing Co., has awarded the contract for a 3 story, 65 x 150 ft. garage including storage tanks and pumps on Front St., to the H. Horst Co., Brumder Bldg., Milwaukee and Rock Island, at $150,000.

Minn., Minneapolis—The Bemis Bros. Bag Co., 604 South 4th St., has awarded the contract for the installation of a steam heating system in the proposed 7 story, 65 x 150 ft. addition to its factory at 600 4th St., S., to the Hankee Heating Co., 922 2nd Ave., S.

Minn., St. Paul—The Bd. Educ., City Hall, has awarded contract for a heating system in the proposed 3 story, 64 x 96 ft. school addition on LaFond and Avon Sts., to the Hankee Htg. Co., 925 Merchants Natl. Bk. Bldg., at $14,108. Noted July 27.

Kan., Geneseo—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Hutchinson — The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water system including pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Kenneth—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons., 3240 South Michigan Blvd., Chicago, Ill.

Kan., Lyons — The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Miller—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Neal—The Missouri Pacific Ry Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Osawatomie—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service system including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Kan., Ottawa—The Missouri Pacific Ry. Co., Ry. Exch. Bldg., St. Louis, Mo., has awarded the contract for a new water service including a pump house, steel tank, distributing system, engine and pump here to Joseph E. Nelson & Sons, 3240 South Michigan Blvd., Chicago, Ill.

Wyo., Salt Creek—The Midwest Refining Co., 1st Natl. Bank., Denver, Col., will build a 2 story, 70 x 114 ft. hotel including a refrigerating plant. About $125,000. Work will be done by day labor.

Mo., St. Louis—The David Rankin Junior School, 4431 Finney St., has awarded the contract for a 1 story power plant, to the J. Stewart & Co., Boatmans Bank Bldg., at $150,000.

Mo., St. Louis—The Landes Machine Co., 407 Gano St., will build a 1 story boiler and machine shop at 4929-31 North 2nd St. About $6,000. Work will be done by day labor.

Mo., St. Louis—The Schulz Belting Co., 4th and Boston Sts., has awarded the contract for a 1 story, 25 x 50 ft. factory and boiler room on South 4th St., to the Dryden Dyer Constr. Co., 816 Olive St. About $6,000.

Mo., St. Louis—J. A Wetmore, Supervising Archt., Treasury Dept., Washington, D. C., has awarded contract for a boiler plant at the Marine Hospital here, to William Wilby, Selma, Ala., at $4,000. Noted July 27.

Ont., Kitchener—The Dominion Tire & Rubber Co., 140 Strange St., has awarded the contract for a 60 x 100 ft. rubber factory, power house and sub-station on King St., to the Caswell Constr. Co., 53 Wellington St., E., Toronto, at $85,000.

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